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## THE EFFECTIVE OF SMART PIANO TO ENHANCE PIANO SKILLS ON CHILDREN

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### Abstract:

This study aims to explore the potential benefits and effectiveness of incorporating smart pianos in the piano learning process for children. The research investigates the impact of smart piano teaching on enhancing piano skills among children. The participants of this study consist of students aged 4 to 6 years old, who are enrolled in a piano learning program that incorporates smart pianos. The research examines the students' progress over a designated period, comparing it with a control group using traditional piano instruction methods. The findings of this study contribute to the understanding of the benefits and limitations of smart piano education in piano education. The results reveal that smart pianos provide interactive learning experiences, including visual feedback, practice assistance features, progress tracking, and individualized learning options. These features positively impact students' engagement, motivation, and overall piano skill development. The implications of this research suggest that smart piano can be a valuable tool in piano education, enhancing students' learning experiences and promoting their overall musical growth. The study calls for further research with larger sample sizes and longer duration to validate and extend these initial findings.

### Keywords:

Smart Piano, Early Childhood Education, Piano Skills, Music Education

### Introduction

With the impact of the new technological revolution and the spread of the global Covid-19 epidemic, smart education has gradually become a hot spot (Zhou, 2021). Smart piano is the

embodiment of the integration of modern science and technology with traditional music. It makes use of new technology to innovate and develop piano career, which is more suitable for teaching than traditional piano, and at the same time helps to improve the efficiency and quality of piano teaching (Li, 2022). Under the background of "intelligence Internet", it is no longer a dream to popularize smart piano equipment, and more and more families choose to accept smart piano (Yi, 2021). The traditional mode of piano education in primary school in China is mostly collective teaching such as individual piano teaching or group piano teaching, which attaches great importance to the cultivation of students' piano playing skills and related theoretical knowledge and emphasizes the importance of "imitation" (Yi, 2021). The form of collective face-to-face teaching can speed up the teaching progress, improve students' self-confidence in playing, and help to create Interdependent teaching environment, etc. (Dochy, 2021).

However, there are some problems in the current piano course education. First, it restricts and hinders the cultivation of students' creative thinking. Second, it can't stimulate interest in piano learning, and third, it lacks interactivity in the classroom (Wang, 2022). Nevertheless, the smart piano not only retains the tone and feel of the traditional piano, but also adds many smart functions, such as game functions, animation videos, and rich curriculum resources and music scores (Liu, 2021). In this approach, students have increased their interest in the learning process, which just solves the problem of traditional music lessons. Therefore, this paper will focus on the application of smart piano supported by information technology in children and explore a new type of piano by deeply analysing the evolution process of smart piano, comparing it with traditional piano teaching and its unique smart technology. The new teaching mode of piano course provides some reference for the future smart piano teaching.

The earliest research on smart piano can be traced back to past study, Li Ping (2005) summarized the teaching mode and development process of smart piano and explored the direction of China's piano education reform. Immediately after that, Wang Y.H (2006) from the perspective of multiple intelligence theory, reflected on the model of group piano lessons in normal schools, and proposed a way to reform: provide a strong starting point, provide appropriate analogies, and provide multiple representations of core ideas. It is a manifestation of smart music education. Qian (2014) explained the importance of smart piano to piano learning through the analysis of piano performance and piano accompaniment. Previous study shown that how to combine the expert system with the most advanced music recognition software and multimedia output equipment at that time to provide a learning environment suitable for beginners of piano according to the needs of students (Dannenberg, 1990). Moreover, Holland (2000) discussed that music is an open field, which needs teachers and students to explore constantly. This paper mainly discusses the main ways of the application of artificial intelligence in music education (Holland, 2000).

Through theoretical research on smart piano teaching, the future development of smart piano is prospected, which has certain significance for our research on smart piano. In addition, domestic scholars have carried out research on the application of smart pianos in specific educational activities. For example, Liu (2016) started from the current situation of music online education, built a "micro-music" network platform, and elaborated on the specific content. "Micro-music" models for children's piano education are described and evaluated. Based on defining the attributes of the piano instrument, Chen (2017) further explained the difference between the smart piano and the traditional piano from the perspective of the development history of the instrument piano, and further explained the difference between the

smart piano and the traditional piano from the perspective of the practicality of the instrument teaching and discussed the "intelligence" in depth. related issues and discusses the practicability of smart pianos and the impact of smart pianos on "teaching and learning" and predicts the popularity and evolution of smart pianos in the future development process. Wen (2018) narrated the practical application and advantages of the "VIP online piano sparring terminal" APP in piano teaching by analysing the practical problems of piano children during practice, confirming that the sparring APP has played a very good auxiliary role in piano teaching, and can solve the practical problems that arise in students' piano practice. Chen (2019) analysed the current main software implementation methods of smart pianos: including music scores, playback, error correction and scoring systems, and summarized the main implementation modes of smart pianos, so that this new method can be better applied to piano teaching. among. The advantages and disadvantages of smart piano teaching have also been studied: for example, Liu (2016) introduced the advantages of the "Micro Music" interactive smart piano platform in piano teaching. The platform focuses on user experience and satisfaction. It can not only provide children with the high-quality teaching resources they need, but also understand children's subjective learning requirements, follow up their current learning levels, and formulate targeted teaching, supervision and guidance plans. , as well as giving timely answers to questions, these teaching contents make "Micro Music" platform pays more attention to students' user experience, learning effects and support services, allowing children to complete learning tasks in games.

## Literature Review

### *Smart Musical Score*

In the smart piano, if the copyright is purchased, all the piano music scores from ancient times can be stored in the built-in computer of the piano in the form of electronic music scores, which can be searched according to the search. Music scores can be directly displayed and read through a 4k ultra-high-definition display screen. Large-screen full-high-definition staff and film display screen can effectively protect children's eyes. Displaying four pages of music scores on the same screen can help children reduce piano music flipping troubles. When playing, the music score is displayed on the screen at the music stand position (Wente, 2016). Moreover, some models of smart pianos can automatically turn pages according to the player's playing progress. In the smart music score, the player can also adjust the size and color of the symbols such as notes, speed marks, dynamics marks, etc. according to his own preferences. For example, it is difficult for children to recognize the traditional music score. The paper version of music score is too small, and it is difficult for piano children to distinguish the position of notes on the staff. Then, on the smart music score, children can increase the size and proportion of music score according to their own requirements (Müllensiefen,2015). In the process of playing, the intensity marks can be marked in red according to one's own preferences, such as "FF", "SF" and other accent marks. Once the player sees the red mark, it will be quickly identified as the accent playing method; Weak tone marks such as "PP" and "MP" are marked with green. Players will play weak tone when they see the green mark. Other marks, such as "presto" and "Legato", can be personalized (Morgan, 2019).

### *Smart Piano Sheet Music*

Smart Piano Sheet Music is also a major feature of some smart pianos. Firstly, it has an automatic error correction system. System, smart piano can put the real audio information played by the player into the melody recognition module for analysis. Moreover, in the process

of students' performance, the smart piano system can accurately evaluate the intonation, rhythm, speed, completeness, expressiveness and technical level in all aspects, and it has a light-following mode, which can detect every note played by the player (He, 2021). Only when the correct note is played will the next light be turned on. In the process of playing, the smart music score will follow up with the students' playing, and the wrong notes will be indicated by red marks, while the correct notes will be represented by green. In addition, the AI smart sparring function is divided into two modes: class and practice. In class mode, children choose songs according to their needs, and carry out targeted learning step by step according to smart voice prompts; AI sparring partners can also analyse the places that need to be practiced according to the children's playing situation, and practice with the baby in a scientific way. In the practice mode, children can choose break-up practice, clause practice and fun practice independently (Yu, & Yang, 2020). Each phrase has two modes: "reading music" and "slow practice". "Reading music" ensures that every sound is played correctly from the beginning. In the process of "slow practice", there are metronomes and accompanying music, so that piano practice is not boring. The smart evaluation function in the practice mode can smartly correct the rhythm and intonation problems in children's practice, and automatically generate an evaluation report, so that preschool children and parents can know about piano practice in time (Konovalova, 2019). Through virtual reward, the function evaluation can make children feel successful, and make them master piano practice methods in a relaxed and happy atmosphere, avoid wrong sounds and fall in love with piano practice (Cheng & Southcott, 2022).

### ***Playback Recording and Video Recording***

Most piano players play as the main body, listening to their own melodies with their ears while playing. However, in the process of playing, it is difficult for players to separate their energy to feel the sound effects of their playing repertoire because most of their attention is focused on playing and technical processing (Becker, 2021). Especially for beginners, it is not easy to distinguish the wrong sounds in the process of playing, let alone feel the contrast between strength and weakness, speed and speed. Therefore, the playback and recording functions of smart piano can be very good. To solve this problem, teachers can choose the function of playing back the video and recording after the students finish playing a song, and let the students listen to their own playing repeatedly, pointing out the problems and playing a more intuitive teaching effect (Creech, 2019).

### ***Entertainment Functions***

In the era of Internet, to further stimulate students' interest in learning piano, the smart piano software designer specially added the link design of the game, which can make most students learn piano in a relaxed and pleasant learning atmosphere. For example, the game of "waterfall flow" means that students can freely choose to play songs in the game (Bobbe, et al., 2021). For most students, by playing on the piano and practicing according to the prompts of led lights, they can learn music easily and quickly, improve their sensitivity to music and stimulate their interest in learning. For example, some smart pianos are introduced into the course through picture-book animation, connecting the learning of each lesson with the animation story in series, combining the game breakthrough with learning music theory knowledge, and matching it with four different practice methods: follow-stop, slow-speed, rhythm and playing. Some also design the learning method of "Kara Piano", which is basically equivalent to the gameplay of "rhythm master" and "dance troupe". Students can choose the one on the smart piano (Zheng, 2022).

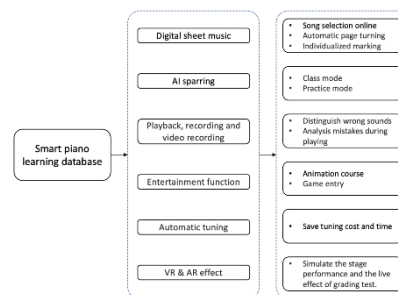
### ***Piano Tuning***

Piano tuning not only requires accurate tone, but also requires that all mechanical parts of the piano be debugged normally, so that the good performance and musical effect of the piano can be fully exerted. Traditional pianos need periodic tuning to maintain the performance of pianos (Lincoln, 2019). However, in the aspect of smart piano, by implanting the work of the intonation meter into the smart piano, the computer will compare the sound emitted by the piano with the sound stored by the computer and bring out the sound with pitch deviation to guide the tuning. This function enables beginners to have a standard pitch hearing in the piano enlightenment stage and can save the tuning cost (Shuo & Xiao, 2019).

### ***VR & AR***

When users wear VR devices, they will be temporarily separated from the real space, from a bystander to an immersive learner, directly immersed in learning. In addition, in the visual experience, the VR imaging will be more stereoscopic and clearer, and every detail of the teacher's actions in the video can be clearly seen, to receive a better teaching effect. To improve students' initiative and entertainment in learning piano, many online teaching software's have developed VR piano games. Students can find a balance between game scenes and real scenes and enhance their sense of experience and fun (Shuo & Xiao, 2019).

With the application of AR technology in piano teaching, more and more students will use this function before participating in the competition. AR technology can superimpose virtual scenes into reality and simulate the real environment such as the competition scene and the grading test (Bobbe, et al., 2021). With the support of Internet of Things technology, audio equipment is used to dub the host, judges and audience according to the competition process, creating a more immersive artistic environment. Through portable devices, students can practice virtual exercises in advance in the practice process and overcome their nervousness and other emotions. AR technology can help students improve their performance ability and psychological adaptability (Liu & Tu, 2020).



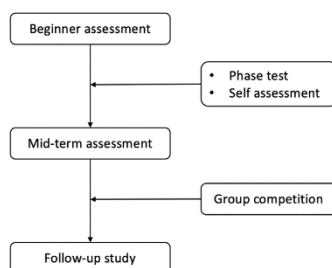
**Figure 1: Smart Piano Learning Database**

### ***Smart Assessment***

The evaluation function of smart piano refers to the ability to score smartly according to the intonation, intensity, rhythm and duration of students' performance. Students' smart evaluation can be divided into three stages: the first stage is to evaluate beginners, and students who use smart piano for the first time should evaluate their piano level, hobbies and expectations, while students who are basic in piano can choose the difficulty to test in smart piano (Zhang, 2022). In the second stage, a study plan suitable for the current stage will be selected according to students' achievements. One-to-many group teaching can be used for junior students, while one-to-one teaching can be used for middle and senior students. After a period of study, take



the mid-term assessment (Bruggeman, 2022). In the third stage, group PK can be used to stimulate students' learning enthusiasm through competition among students. In addition, students can evaluate their learning satisfaction through self-assessment. Hence, teachers can make some improvements in the teaching process (Cosi, 2020).



**Figure 2: Smart Assessment System**

## Methodology

### *Smart Piano Teaching Model*

There are three kinds of teaching model in the smart piano platform, that is physical teaching, online teaching, self-study. First lesson and second lesson are smart piano group course, and from third lesson to sixth lesson are smart piano individual course. The last class is to examine the result of students learning, and it used the smart piano scoring function to let students have a piano competition in this phase. More importantly, it can adjust teaching progress depend on learning result and detection data, which completely press smart piano's advantage.

### *Learning Content and Skills*

In the initial stage, students mastered the creation background and style of the melody. Play the notes and musical terminology in the piece with accuracy, and mastered the fundamental aspects of music, including pitch, dynamics, and fingering. Combining network and multimedia tools with piano instruction can help students absorb music-related information, enhance their overall creative accomplishment, gain a deeper comprehension of musical compositions, and develop more acute hearing. Solo performances can be challenging, as different composers' and genres' works call for varying degrees of expertise. Thus, the greatest priority is to master rational and scientific practice methods and get beyond performance skill challenges.

### *Self-study Phase*

After the teacher assigned the task, the students read related text materials such as composer's introduction and melody creation background, which content can help students understand the melody quickly. Next, students watched performance videos from famous pianist and instructional videos. Besides, students read fingering and notes of the melody to study difficulty tricks in the melody such as chord progression, multi-part playing, interval jumping. The students tried to practice at slow pace at first. They can make an online appointment for one-on-one guidance from teachers, if they encounter some unsolvable problems. The computer determines the qualification rate of fundamental musical elements like pitch and rhythm when it can be played completely. After that, modify your study strategy and direct your students to practice in a specific way.

### ***Online and Physical Teaching***

Students have mastered basic fingering and rhythm through self-study. In online or physical class, teachers listened to play the whole piece from student, and explain performance methods and process works, especially the difficulties and skills of this work in the class. Next, students performed this work completely after instructed by teachers, and the computer and the teacher provide a comprehensive evaluation of the students' learning outcomes, which are more accessible to plan future study.

### ***Procedure***

The teaching method took smart piano as teaching platform, which was divided to three stages, namely self-study, online learning and classroom teaching. The computer fully utilized the teaching benefits of the smart piano by adjusting the teaching process in real-time in accordance with the learning scenario and detection data. As a piano teacher in China, researcher will the students from different piano class as participants, and they were willingness to join in this smart piano study. As such, to verified whether it is feasible to apply the smart piano to piano teaching in children.

The first experiment design is smart piano teaching course, and the piano solo is used as teaching case. In this study, researchers choose 《Bagpipe dance of Mozart》 as teaching repertoire. In the first- and second-week teaching, basic teaching was conducted including creation background, composer's style and melody rhythm etc. Start with third week, the students tried to performance the melody and add emotion express. Next, the students could play faster and found out problems in the playing. They can make the appointment online class to solve their problems. In the end, smart piano gave assessment through piano competition function in the sixth week, as shown below Table 1.

The second experiment design is traditional piano teaching course and used the same melody as the first experiment. Researcher collected teaching feedback from students and examined student completion. In sixth week, combination students' acceptance ability and basic piano playing ability, the teacher evaluated students' performance level and gave a mark, as shown below Table 2.

**Table 1. Smart Piano Teaching-take “Bagpipe Dance of Mozart”**

Teaching time (week)	Course form	Teaching content	Teaching method	Student recognition	Teaching feedback	Student completion
First	Smart piano group course	Melody introduction	1.Explain the composer's style 2.Explain the creation background	Generally	Clear perception of the melody	100%
Second	Smart piano group course	Music analysis	1. Teacher demonstrates playing 2. Students can read music scores	Generally	Students' playing rhythm have improved	100%

			3. Use the smart piano to play rhythm			
Third	Smart piano individual course	Student practical	1. Use the automatic error correction function of smart music score to view practice errors 2. Use the playback function to find out the rhythm problem	Excellent	Improve the efficiency of playing piano.	80%
Fourth	Smart piano individual course	Playing emoticons	1. Add emoji to playing 2. Use the playback function to find out the emoticons problem	Excellent	Limited music performance	85%
Fifth	Smart piano individual course	Playing speed	1. Play the music at the original speed 2. Use the playback function to find out the speed problem	Excellent	Speed training can be carried out following the automatically played tracks of the piano only	90%
Sixth	Smart piano individual course	Performance competition	1. Use the smart piano scoring function to let students have a piano competition	Excellent	Greatly improve the motivation of piano practice, and the smart piano competition is very interesting	100%



**Table 2. Traditional Piano Teaching-take 《Bagpipe Dance of Mozart》**

Teaching time (week)	Course form	Teaching content	Teaching method	Student recognition	Teaching feedback	Student completion
First	Traditional piano group course	Melody introduction	1.Explain the composer's style 2.Explain the creation background	Generally	It's difficult to remember	100%
Second	Traditional piano group course	Music analysis	1.Teacher demonstrates playing 2. Students read music scores 3.The teacher leads the students to play rhythm	Generally	Boring in playing rhythm	100%
Third	Traditional piano individual course	Student practical	1. Students contact, and teachers provide one-to-one manual guidance 2. The teacher summarizes the common problems and demonstrates the correct rhythm and sound pattern again	Good	Less targeted guidance and practice inefficiency	70%
Fourth	Traditional piano individual course	Playing emoticons	1. Add emoji to playing 2.Students mark expression marks on paper music scores	Generally	Insufficient expressiveness, easy to ignore expression marks	65%
Fifth	Traditional piano individual course	Playing speed	1. Use the metronome, and the students play at the normal speed	Bad	Playing skills are less affected by pre-teaching	70%
Sixth	Traditional piano individual course	Performance competition	1.Students perform in a competition and teachers score	Bad	There is no motive in the competition, and the teacher's	50%

## Discussion

Through design analysis and comparison with the same teaching content, different class teaching form, it is obvious that the teaching effect of smart piano is far better than that of traditional piano teaching from received teaching feedback and the data of teaching practice. The first week is like the second week in terms of student recognition and student completion. However, start with the third week, about traditional piano teaching, teaching effect of students' feedback became bad and student completion were increasingly decrease, namely 50% in the sixth week, while student completion data of smart piano teaching reached 100%. This study demonstrated that smart piano teaching approach can stimulate students' enthusiasm and increase interactive in the class. Diverse functions of smart piano make up for traditional piano teaching, which make full use of its advantages.

We can be seen that smart piano teaching approach has a certain feasible through comparing traditional piano teaching approach with smart piano teaching approach. In traditional piano teaching, convey knowledge by oral or text as a main way. While picture and video are main convey way in the smart piano teaching, this method is more direct and understandable for students. It can motivate students' enthusiasm and active their interest in piano, especially for beginners. In addition, students can take part in piano test and competition through smart system, which conducive to examine study result and strengthen weakness on time. As such, smart piano teaching take advantage over traditional piano teaching, it is not only stimulating students' auditory and visual, but also can increases the standards for the quality of student learning, broadens the path available to students for information acquisition, and enhances the effectiveness and quality of instruction.

## Conclusion

In the context of smart environment, smart piano is an indispensable product in college teaching. Students will get rid of mechanized and simplified in smart piano teaching through functions of smart system (Niu, 2021). This study compared the difference between traditional piano teaching and smart piano teaching in the six weeks teaching. Research has found that children who use Smart Pianos experience significant improvements in piano skills. Includes improvement in technical ability, music theory understanding, sight-reading ability, and overall musicality. At the same time, through the observation during the research process, the smart piano has a positive impact on children's motivation and participation in piano learning. You can discover the interactive features, gamification elements and progress tracking mechanism of the smart piano, which can improve children's enthusiasm for practice and cultivate a sense of accomplishment. Additionally, the study could highlight the importance of effectively integrating smart technologies into music education. It can provide insights into best practices for incorporating smart pianos and related technologies into teaching methods to optimize their impact on the development of children's piano skills. The result is indicated that smart piano teaching is more effective, no matter in cultivating musical emotion or training piano playing speed. Future work should include exploration on the combination of smart piano and traditional piano teaching approach and making most full of their advantages.

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## References

- Becker, J., & Becker, A. (2021). 14. A Musical Icon: Power and Meaning in Javanese Gamelan Music. In *The sign in music and literature* (pp. 203-215). University of Texas Press.
- Bobbe, T., Oppici, L., Lüneburg, L. M., Münzberg, O., Li, S. C., Narciss, S. & Muschter, E. (2021). What early user involvement could look like—developing technology applications for piano teaching and learning. *Multimodal Technologies and Interaction*, 5(7), 38.
- Bobbe, T., Oppici, L., Lüneburg, L. M., Münzberg, O., Li, S. C., Narciss, S., ... & Muschter, E. (2021). What early user involvement could look like—developing technology applications for piano teaching and learning. *Multimodal Technologies and Interaction*, 5(7), 38.
- Bruggeman, B., Garone, A., Struyven, K., Pynoo, B., & Tondeur, J. (2022). Exploring university teachers' online education during COVID-19: Tensions between enthusiasm and stress. *Computers and Education Open*, 3, 100095.
- Chen Rui. (2017). The development of smart piano and its universality. *Music Creation* (10), 192-194.
- Chen Si zhe. (2019). Talking about the implementation method of smart piano software system. *New Sound of Music (Journal of Shenyang Conservatory of Music)* (02), 109-114.
- Cheng, Z., & Southcott, J. (2022). Practice and learning the piano: Motivation and self-regulation. *International Journal of Music Education*, 02557614221125173.
- Cosi, A., Voltas, N., Lázaro-Cantabrana, J. L., Morales, P., Calvo, M., Molina, S., & Quiroga, M. Á. (2020). Formative assessment at university through digital technology tools. *Profesorado, revista de currículum y formación del profesorado*, 24(1), 164-183.
- Creech, A. (2019). Using music technology creatively to enrich later-life: A literature review. *Frontiers in psychology*, 10, 117.
- Dannenberg, R. B., Sanchez, M., Joseph, A., Capell, P., Joseph, R., & Saul, R. (1990). A computer - based multi - media tutor for beginning piano students. *Journal of New Music Research*, 19(2-3), 155-173.
- Dochy, F., & Segers, M. (2021). High Impact Learning that Lasts: Future-proof Learning and Development. In *Theories of Workplace Learning in Changing Times* (pp. 15-47). Routledge.
- He, B. (2021). Video teaching of piano playing and singing based on computer artificial intelligence system and virtual image processing. *Journal of Ambient Intelligence and Humanized Computing*, 1-12.
- Holland, S. (2000). Artificial Intelligence in Music Education: A Critical Review.
- Konovalova, S. A., Tagiltseva, N. G., Matveeva, L. V., Suetina, A. I., Ovsyannikova, O. A., & Mokrousov, S. I. (2019). Smart e-learning in the preparation of novice pop vocalists in the university. In *Smart Education and e-Learning 2019* (pp. 169-175). Springer, Singapore.
- Li, L. (2022). Design and Application of the Piano Teaching System Integrating Videos and Images. *Scientific Programming*, 2022.
- Lian Ping. (2005). A new impetus for piano music education reform in China - A new model of digital piano music teaching. *Journal of Xinghai Conservatory of Music* (03).
- Lincoln, H. B. (Ed.). (2019). *The computer and music*. Cornell University Press.

- Liu Haiyun. (2016). The application of "micro music" web-assisted interactive platform in children's piano social teaching. *Music Time* (06), 51+50.
- Liu, C., & Tu, B. (2020). Network piano teaching platform based on FPGA and machine learning. *Microprocessors and Microsystems*, 103414.
- Liu, M., & Huang, J. (2021). Piano playing teaching system based on artificial intelligence—design and research. *Journal of smart & Fuzzy Systems*, 40(2), 3525-3533.
- Morgan, W. B. (2019). RHYTHMIC, PHRASING, AND DRAMATIC CONCERNS IN POULENC'S TEL JOUR, TELLE NUIT (Doctoral dissertation, Temple University Libraries).
- Müllensiefen, D., Harrison, P., Caprini, F., & Fancourt, A. (2015). Investigating the importance of self-theories of intelligence and musicality for students' academic and musical achievement. *Frontiers in psychology*, 6, 1702.
- Niu, Y. (2021). Penetration of multimedia technology in piano teaching and performance based on complex network. *Mathematical Problems in Engineering*, 2021.
- Qian Zhimei. (2014). Research on piano teaching in the context of smart interaction. *Art 100* (04), 252-253.
- Shuo, C., & Xiao, C. (2019). The construction of internet+ piano smart network teaching system model. *Journal of smart & Fuzzy Systems*, 37(5), 5819-5827.
- Wang Yehong. (2006). The theory of multiple intelligences and the reform of piano group class teaching for senior teachers. *China Music* (04), 169-172.
- Wang, G. (2022). Research on the Development of College Music Education under the New Media Environment. *International Journal of Education and Humanities*, 4(3), 206-209.
- Wen Jingjing. (2018). Research on the infiltration of "VIP online piano accompaniment end" APP into piano teaching. *Northern Music* (10), 222.
- Wente, A. R. (2016). *Magical mechanics: the player piano in the age of digital reproduction* (Doctoral dissertation).
- Yiran, F. (2021). The role of the Chinese piano school in the formation of the Chinese piano art. *Linguistics and Culture Review*, 5(S4), 44-55.
- Yu, Z., & Yang, B. (2020, October). Research on piano performance strength evaluation system based on gesture recognition. In *2020 13th International Conference on smart Computation Technology and Automation (ICICTA)* (pp. 198-205). IEEE.
- Zhang, W. (2022). Practice and Exploration of Music Solfeggio Teaching Based on Data Mining Technology. *Journal of Environmental and Public Health*, 2022.
- Zheng, Y., Tian, T., & Zhang, A. (2022). Training Strategy of Music Expression in Piano Teaching and Performance by smart Multimedia Technology. *International Transactions on Electrical Energy Systems*, 2022.
- Zhou, X., Zhang, Y., & Wang, Y. (2021, January). Analysis on the Venations, Hotspots and Trend of China's Education Informatization Research in the Post-COVID-19 Era. In *International Conference on Computer Science, Engineering and Education Applications* (pp. 454-465). Springer, Cham.