

# Enhancing Vocal Pedagogy Through Digital Audio Technology: A Case Study of Popular Singing Education at Sichuan Conservatory of Music, China

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## ABSTRACT

This study aims to explore the application and effectiveness of digital audio technology (DAT) in music education, especially vocal teaching. Through a case study of the popular singing course of the Sichuan Conservatory of Music, this study focuses on how digital audio workstations (DAW). The study was conducted through a quantitative questionnaire survey of 60 students, divided into a control group of 30 people participating in DAT-enhanced teaching and a control group of 30 people receiving traditional teaching, to analyse the impact of DAT on classroom efficiency and student learning motivation. Data analysis shows that the introduction of DAT significantly improves teaching efficiency and stimulates students' interest in learning. In addition, this study discusses how DAT promotes the mastery of vocal skills, especially in pitch, rhythm and timbre processing. It helps students better understand and control vocal expression through technical means. The results of this study show that DAT has a high application value in the field of music education, is especially suitable for the modern development needs of vocal education and can effectively promote the improvement of teaching effects.

## INTRODUCTION

Since 2017, the researcher has worked as a music production lecturer at the Sichuan Conservatory of Music in China. During this time, I have paid attention to the impact of digital audio technology on the conservatory curriculum. Thanks to the advancement of science and technology and the popularisation of computers, digital technology has already penetrated the field of music education. It provides more possibilities for developing music education and points out a new reform direction. Giddings (2020) stated that in order to maintain students' efficient learning in music classes, digital technology should be used to allow them to collaborate and

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practice better and ensure that every student can use music software to experience the fun of learning music perfectly. Effectiveness requires the support of teachers and giving students the correct guidance, experience, and collaboration. So, as music educators, our purpose is to inspire students to become lifelong learners and participants in music. However, do we fully understand the current teaching technology and have the corresponding skills? This is a thought-provoking question: how to improve teachers' teaching effectiveness with the application of DAT, how to stimulate students' interest in learning music, and how to deal with the many challenges faced by DAT in music education, thereby improving the quality of teaching.

In this article, I use the popular singing class of Sichuan Conservatory of Music as a case to analyse and explore, aiming to show the correlation between digital audio technology and music education and the current situation of using digital audio technology in college courses. Raposo et al. (2019) contend that becoming a teacher involves prioritising learning over teaching. The concept of the "self-made man" may lose significance if access to vast amounts of information becomes more convenient, making it more straightforward to acquire knowledge beyond the confines of traditional education. School should be viewed as a place that fosters learning and drive, which are frequently lacking. Thus, the precise direction of teachers in the classroom is crucial for fostering students' willingness to learn music. As the theory has confirmed the use of technology-based music instruction, such as DAT, to support music learning, it is essential to find empirical proof for real practice (Dorfman, 2022). With this problem in mind, this study is undertaken with the objective of elucidating the function of technology within the domain of music education. Adopting the pedagogical viewpoint of the instructor and situated within the formal setting of the conservatoire, the research endeavours to discern the mechanisms by which technological integration can facilitate a more efficient enhancement of students' professional competencies.

### **Purpose of the study**

This study aims to explore the application of digital audio technology (DAT) in music education, especially in popular vocal courses. With the widespread application of technology in education, the role of DAT in music teaching has gradually attracted attention. However, there is still a lack of systematic empirical research on how to effectively integrate this technology in the classroom to optimise teaching effects and improve students' learning experience. Therefore, this study uses a case study of the popular singing course of the Sichuan Conservatory of Music to explore how DAT can play an auxiliary role in the traditional vocal teaching model, thereby improving teaching quality and promoting students' learning enthusiasm.

### **Research Objectives**

- i. Clarify the actual application scenarios and operation procedures of DAT in popular vocal courses, including key links such as audio processing, rhythm control, and timbre adjustment.
- ii. Evaluate the impact of DAT on teaching efficiency and student learning motivation and analyse whether the technology can stimulate students' learning interest and participation.
- iii. Compare the differences in the effects between the DAT-enhanced teaching method and the traditional vocal teaching model, especially in improving students' skills such as pitch, rhythm, and timbre control, to verify the application potential of DAT in modern vocal education.

## Research Questions

- i. What are the specific aspects of the application of digital audio technology in popular vocal courses? For example, does it include recording analysis, instant feedback, and personalised guidance?
- ii. After using DAT, has the teacher's teaching efficiency in the classroom been improved? Has the application of technology enhanced the student's learning motivation?
- iii. Compared with the traditional teaching model, can DAT significantly improve students' performance in pitch, rhythm, and timbre control?

In summary, the researchers hope to be guided by the exploration of integrating technology into music education and to provide strong empirical support for the effective application of DAT in music education, which can not only provide practical guidance for the integration of technology into music education but also point out the direction for the modernisation of vocal courses in the future.

## LITERATURE REVIEW

### Current Situation and Problems

Existing research shows that the application of digital audio technology (DAT) in music education has gradually become popular, especially in Chinese classrooms. However, the current literature is mainly descriptive when describing the application of DAT, lacking critical analysis and in-depth discussion of the differences between different studies. Raposo (2019) emphasised that the application of DAT in the classroom requires teachers' correct guidance to ensure technology's effectiveness in teaching; however, it did not fully explore how the differences in teachers' acceptance of technology affect teaching effectiveness. Bresler (2021) further proposed that formative research can help better apply technology in the classroom and promote the transformation of teaching models, but this transformation also faces the challenge of unbalanced technical skills. This difference in technology acceptance is particularly evident between teachers and students and has become the main limiting factor for the promotion and application of DAT in classroom teaching. To provide a more comprehensive perspective, global literature on the application of DAT should be included. Bell (2020) pointed out that DAT can stimulate students' interest in learning but also found that the effectiveness of technology use is subject to teachers' technical level and resource acquisition. Pondaco (2021) also proposed that DAT classes require teachers to change from knowledge transmitters to "facilitators" of learning, and this role change increases the complexity of teaching interactions. However, some studies believe that DAT can enhance students' autonomous learning ability, while others point out that technology may weaken direct communication between teachers and students. Exploring these different perspectives can help us better understand the application effects and limitations of DAT in different cultures and education systems.

There are also research gaps in the existing literature, lacking a systematic comparison of the specific application effects of DAT. For example, although the role of DAT in improving skills such as pitch, rhythm, and timbre has been proven, further research is needed on integrating DAT technology in different teaching environments and achieving the expected results. Healey and Enns (2012) emphasised the advantages of DAT in improving visual memory and attention, which provides a new perspective for the diversified application of DAT.

To enhance the theoretical basis of the study, this study regards the application of DAT as a means to promote students' autonomous learning based on constructivist learning theory (Blackburn et al., 2014). This theoretical background provides rationality for the application of

DAT in music education and explains why DAT can effectively improve students' learning experience and classroom participation in the teaching environment.

### **Teaching design of digital audio technology in popular singing courses**

In popular vocal courses, the application of DAT aims to improve students' core singing skills, including timbre control, emotional expression, rhythm control and stage performance. These skills are particularly critical in popular vocal music. DAT provides more scientific and systematic support for the teaching process, making the teaching and learning these skills more efficient. Specifically, the application of DAT enables teachers to no longer rely solely on traditional subjective evaluation of hearing but to conduct precise analysis through technical tools such as digital audio workstations (DAWs).

The real-time data feedback provided by these tools helps teachers quickly identify students' specific problems in pitch, rhythm and timbre processing and provide targeted guidance. Through DAT, teachers can collect and replay students' singing data during teaching so that students can objectively self-examine and understand their shortcomings, thereby improving their self-correction ability. This kind of technical assistance not only enhances the interactivity of classroom teaching but also gives students more space for independent learning, allowing them to practice and self-evaluate repeatedly outside the classroom. At the same time, DAT makes the presentation of teaching content more intuitive, such as audio waveforms, spectrograms, and dynamic volume control. Technical visualisation information not only helps students understand technical points but also deepens their understanding of sound processing. Overall, the application of DAT in popular vocal teaching not only optimises the efficiency of the classroom but also effectively improves students' learning experience, making it easier for them to master the complex performance skills in popular vocal music so that they can step onto the stage more confidently.

### **The structure of the DAT in a classroom devoted to pop singing**

In popular singing teaching, the digital audio technology (DAT) system usually consists of two parts, hardware and software, providing comprehensive support for teaching activities. The hardware part includes computers, audio interfaces, microphones, monitoring devices, and MIDI input devices, which are responsible for audio signal input, output, and monitoring. As the core device, the computer provides a running platform for software such as digital audio workstations (DAWs) and stores and processes audio data required for teaching. The audio interface converts analogue and digital signals to each other, making recording and playback more accurate. The microphone is used to capture the singing timbre of students. At the same time, the monitoring device helps teachers and students hear high-quality audio in real-time to ensure the authenticity and detail of the sound. The MIDI input device provides control over electronic instruments, allowing teachers to demonstrate through tools such as electronic synthesisers.

The software part includes DAW and its sound source plug-ins and sound effect plug-ins. As the core platform of digital audio technology, DAW can support the entire process from recording to post-processing. The sound source plug-in provides a variety of virtual instruments and sound effects, enriching the sound performance in the classroom. In contrast, the sound effect plug-in optimises the timbre and adjusts the rhythm, helping students better understand all aspects of vocal music. For example, in DAW, teachers can simulate a variety of accompaniment styles through sound source plug-ins to provide students with a realistic singing environment; sound effect plug-ins can be used to adjust the pitch and intonation of students' singing to assist in

teaching feedback. Table 1 shows the hardware and software requirements for building a music classroom equipped with DAT.

Table 1. The structure of the DAT in a classroom devoted to pop singing

Part	Components	Functions
<b>Hardware Part</b>	Computer:	Hardware and software are used to interface with digital audio and process and edit audio signals.
	Audio interface:	Used for converting digital and analog signals and assisting the computer in completing the input and output of audio signals.
	Microphone:	Used to record singing.
	Monitoring equipment:	Used for monitoring audio recording, editing, and processing.
	MIDI input device:	Used to transmit MIDI standard signals to complete the interaction between MIDI instruments and controllers.
<b>Software Part</b>	Digital Audio Workstation (DAW):	As the most intuitive way to present digital audio technology, the Digital Audio Workstation (DAW) is an important carrier and platform for this technology. On this basis, we can use various music software to record, detect, and adjust sounds and use MIDI technology to compose, arrange, and do other music creation-related work.
	Sound source plug-in:	Plug-in software provides virtual instrument sounds for DAW.
	Audio effect plug-in:	Plug-in software used to monitor and process the sound of audio tracks.

This combination of hardware and software enables DAT to achieve instant feedback and diversified teaching activities in the classroom. For example, through the collaboration of hardware and software, teachers can record and play students' singing performances in real-time and perform visual analysis in DAW to identify subtle problems in intonation, rhythm or timbre, to guide students in a targeted manner. This technical structure not only improves teaching efficiency but also enhances students' sense of participation and achievement in the learning process. Figure 1 shows how each device is connected, and Figure 2 shows the sound source and sound effect plug-ins running on DAW, further enriching the practical teaching experience the classroom.

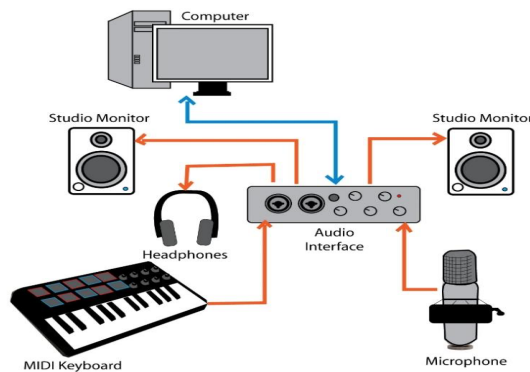


Figure 1. Digital audio equipment connection instructions diagram



Figure 2. Sound source plug-ins and effect plug-ins running on DAW software

### The application of DAT in popular singing classes

Teachers in a music classroom equipped with digital audio technology can use DAW to teach students. Generally speaking, the teaching process for music lessons with the help of DAT technology is as follows:

- a) Teacher explanation: The teacher first explains the knowledge points and performance skills of the songs that the students want to sing.
- b) Demonstration recording: The teacher demonstrates singing once and uses DAW to record it for students to imitate.
- c) Student singing: Perform singing exercises based on the teacher's explanations and demonstrations. The teacher can also make a preliminary assessment of the students' singing ability during this link.
- d) Student recording: After several singing exercises, students will record their singing for analysis and comparison in subsequent sessions.
- e) Analysis: Use digital audio software to analyse the recorded audio track's pitch, timbre, and rhythm to assist teachers in identifying problems and deficiencies in students' singing.

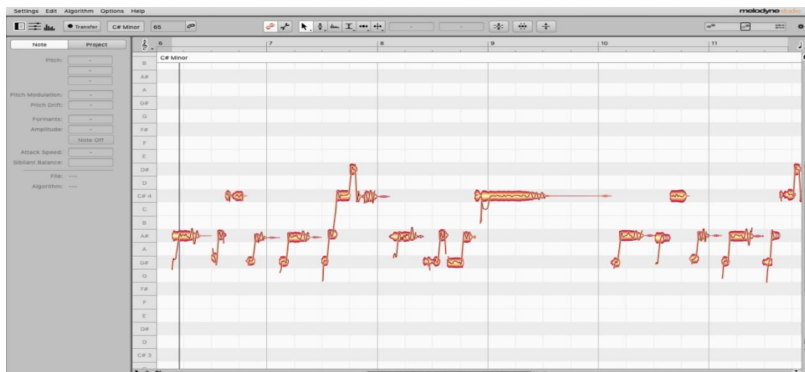


Figure 3. Monitoring of vocal pitch and rhythm in DAW software.

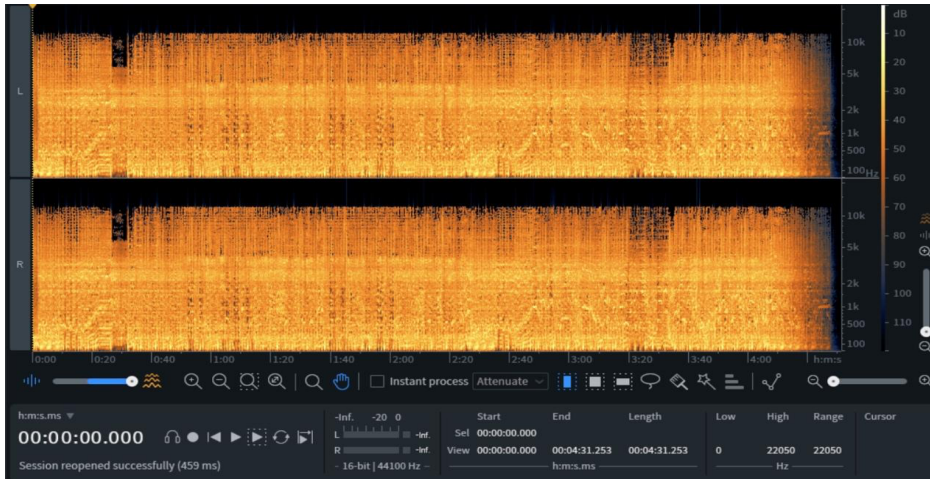


Figure 4. software RX9 detects the spectrogram of human voice timbre

- a) Teacher guidance: Provide targeted guidance to students based on the results of the analysis.
- b) Student singing: After recording analysis and teacher guidance, summarise the problems, correct and improve the singing method, and practice singing again.
- c) Recording comparison: Record students' singing after guidance and compare it with before to help teachers and students summarise problems and improve solutions.

Assign homework: The teacher completes the guidance of students' singing skills through this lesson and assigns targeted homework based on the problems that arise during students' singing



Figure 5. A pop singing teacher is using a DAW in his classroom

## RESEARCH METHOD

### Research Design and Sampling

This study draws on the research method proposed by Jiao (2020). It explores the teaching effects of digital audio technology (DAT) and traditional teaching methods (TMC) in music classrooms through comparative experiments and semi-structured interviews. The research sample includes 60 students from the popular singing course of the Sichuan Conservatory of Music. The participants are evenly distributed in terms of gender, age, and music foundation to ensure the representativeness of the sample and the comparability between groups. The 60 students were randomly divided into 6 groups, of which three used DAT teaching (DAT Group) and the other three used traditional teaching methods (TMC Group). When grouping, the students' music learning background and current vocal ability were taken into account to match the balance between groups, thereby improving the reliability of the study. To measure the performance differences between students in the DAT and TMC groups, this study designed a questionnaire containing scales, open-ended questions, and semi-structured interviews. The scale of the questionnaire assessed students' learning motivation, class participation, and adaptation to DAT, while the open-ended questions allowed students to express their insights into their classroom experience. Semi-structured interviews further explored students' feedback on different teaching methods, especially their feelings about the application of DAT in the classroom. To ensure the validity of the questionnaire and interview tools, the study was pre-tested before the formal launch, and some items were modified based on feedback. During the data collection process, this study focused on three key teaching effect indicators: on-site performance, ability growth, and error rate. On-site performance was scored through instant classroom tests, and teachers scored students based on their pitch, rhythm, and timbre control. The ability growth indicator compared students' progress in pitch, rhythm mastery, and timbre control through pre- and post-measurements. The error rate refers to the number of mistakes made by students during singing, which measures the impact of teaching methods on students' accuracy. Each student received four hours of pop singing teaching per week during the one-month course experiment. After the course, the researchers objectively evaluated the performance of each group of students. Descriptive statistics and variance analysis were used for data analysis to compare the differences between the DAT group and the TMC group in various indicators and verify the significance of the teaching method on students' learning effects. Through careful group matching, tool validation, and objective multi-dimensional evaluation, this study strives to ensure the scientific nature of the research methods and provide reliable empirical support for the application of DAT in popular vocal teaching.

## FINDINGS

As shown in Table 2, DAT students performed better than TMC students. There were more excellent DAT students (43.3%) as compared to TMC students (33.3%) (refer to Table 2 and Figure 6).

Table 2. Overall Performance of DAT vs TMC groups

Singing Performance							
	excellent	%	sound	%	poor	%	total
DAT (digital audio technology) group	13	43.3	12	40.0	5	16.7	30
TMC (non-DAT using) group	10	33.3	11	36.7	9	30.0	30



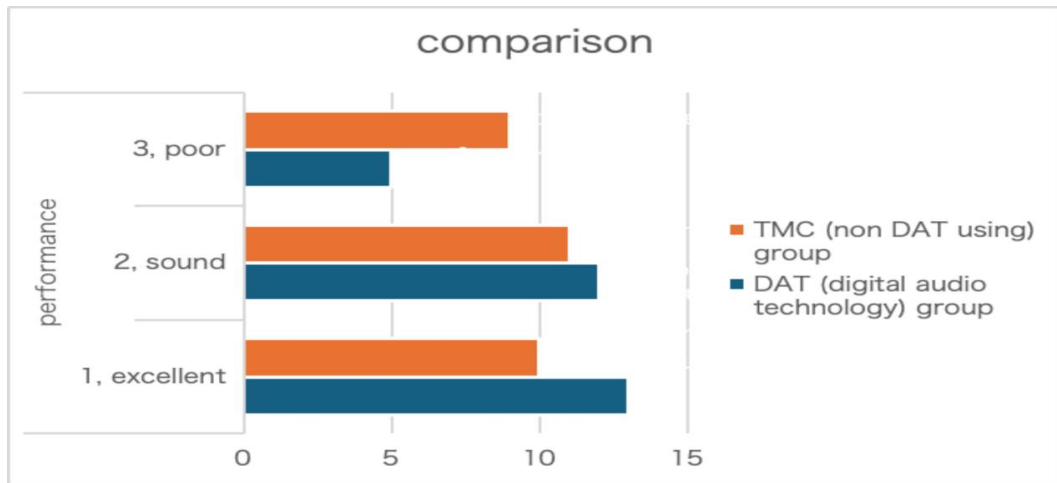


Figure 6. Overall performance of DAT vs TMC groups

As shown in Table 3, DAT excellent students (95%) outperformed non-DAT excellent students (90%). Regarding ability growth, sound DAT students (84%) outperformed non-DAT sound students (70%) as well. On the other hand, it was observed that the error rates of non-DAT poor students (44%) were higher than those of DAT poor students (34%).

Table 3. Performances on on-site assessment, ability growth and error rate of DAT vs TMC students

	On-Site Assessment	Ability Growth	Error Rate
DAT (digital audio technology) group			
1, excellent	95	82	8
2, sound	88	91	15
3, poor	75	84	34
TMC (non-DAT using) group			
1, excellent	90	73	12
2, sound	82	70	20
3, poor	68	65	44

Although this research is in its infancy and needs to continue, judging from the current small-scale surveys and studies, digital audio technology has a significant role in promoting the teaching effect of music classrooms.



Figure 7. Comparison chart of assessment results

An analysis and comparison of Figure 7 shows that in classrooms where digital audio technology is used in music teaching, students can achieve more obvious skill improvements in the short term. At the same time, the control of error rates during performances will be improved. Traditional music classroom teaching also has specific effects, and students' abilities have improved, but it is inferior to classrooms with digital audio technology. This shows that the application of digital audio technology in music classrooms has a very positive impact on the quality of teaching.

## DISCUSSIONS AND CONCLUSION

The results of this study have confirmed that DAT students as a whole outperformed non-DAT students. It was also found that DAT students performed better than non-DAT students in the aspects of on-site assessment and ability growth. Regarding error rates, it was observed that the non-DAT students had higher rates than those DAT students.

This study has confirmed that using DAT benefits students in developing their performance skills, as shown in other studies, such as Aufegger et al. (2017) and Havige (1998). The comparative study method is often used to confirm the integrated utilisation of DAT compared to traditional non-DAT teaching (Havige, 1998). The students are able to use DAT to improve their performance as the visualisation of the device is very helpful in informing areas that they can improve which the improving of learning is with the support of the DAT tool with image-related guidance (Geronazzo et al., 2017). The computer graphics of DAT enhance attention and visual memory and ease students' understanding, leading to better performances (Healey & Enns, 2012).

The challenges of integrating DAT lie in the technological skills that the music teachers have (Bannerman, & O'Leary, 2021; Bell, 2015). Therefore, it implies that music teachers' DAT should be included in the music teachers' education curriculum in which DAT utilisation facilitates and promotes music learning (Bell, 2018, 2019, 2020; Bell & Satarasinghe, 2022). Formative research can be done for music education, which calls for the active use of DAT as a viable tool for informed change in music education (Bresler, 2021). Evaluation of teachers' technological skills in using

DAT in music education through the lens of constructivism is hence imperative (Burrows & Brown, 2019).

This study has also ascertained that DAT is a helpful tool that students can use anytime and anywhere to support their learning. It is also in line with the mindset of constructivist learning in which media of learning can be supportive in making learning occur without being dependent on the instructors (Blackburn et al., 2014).

Technology can enrich the content and form of classroom teaching, but students must be guided correctly to make technology an effective means of music teaching. Tan (2021) believes that as a music teacher, you should change your concept and serve as a facilitator who can provide guidance and help to students rather than just a teacher who imparts knowledge. According to Pondaco's (2021) discussion, technology-based music classes can encourage students to use DAT to learn and practice, but this kind of class is not perfect, and at the same time, it will also have more requirements for teachers. Whether DAT will hinder communication between teachers and students, whether students can accept DAT in the classroom, and whether teachers can skillfully apply DAT all remain to be studied. Raposo et al. (2019) believe that today, with the rapid development of technology, the roles of teachers and educators are still important in modern society. We must realise that even though technology can be conveniently used now, teachers are still real and virtual. , the bridge between technology and science, curriculum and skills, and cognitive and emotional worlds. According to Clauhs et al. (2019), music technology is used in traditional music courses just as DAT is used in conservatory courses. Such an approach may also help to promote the transformation of the school's teaching atmosphere into a student-centred one and provide students with a better learning experience.

For future research, DAT can be used along with virtual reality devices (Bissonnette, et al, 2016). This is because DAT can provide learning environments that lessen students' music performance anxiety and enhance performance quality using DAT for music training.

The limitation of this study lies in the limited number of participants. Future research should expand the number of samples to validate the effectiveness of DAT use in supporting music performance training. Another limitation of this study is the location of the study. As it is only one case of a location involved in the study, more locations should be included in future research to confirm the results of the study. Besides, this study has only used descriptive analysis. For future research, inferential analysis should be employed to statistically confirm the differences between the performances of DAT and non-DAT groups.

In conclusion, DAT utilisation should be incorporated into all conservatory courses. With the utilisation of DAT, this student-centred approach certainly assists in heightening the outcome of learning and giving a high level of learning support that yields affirmative performances.

## **FURTHER STUDY**

This study provides preliminary results in exploring the application of digital audio technology (DAT) in music education, but some limitations need to be further explored in future studies. First, the participant sample's size and geographical limitations may affect the research results' generalizability. Future studies can expand the sample coverage and verify the application effect of DAT in music classrooms with different educational backgrounds. In addition, this study did not conduct a detailed analysis of the changes in interaction between teachers and students, while Pondaco (2021) pointed out that DAT may weaken teacher-student interaction to a certain extent. Future research should further focus on how technology integration affects the quality of

classroom communication and introduce qualitative interviews or observational studies to capture the possible changes in interaction in the classroom to deeply understand the potential impact of DAT in the teaching process. Another direction worthy of further study is the adaptability of DAT in different courses and educational models. This study mainly focuses on popular singing courses, but the role of technology in other music courses, such as instrumental music, composition, music theory, etc., is not clear. Future research can compare and analyse the applicability of DAT in various music courses to explore DAT integration strategies in different teaching environments. In addition, teachers' technical ability and attitude have an important impact on the effectiveness of DAT. In the future, targeted research projects can be designed to study how to improve teachers' acceptance and proficiency of technology and ensure the effective application of technology.

In conclusion, the potential of DAT in music education requires more interdisciplinary and multi-method research support. Future research can provide more comprehensive empirical evidence for promoting the digital transformation of music education by addressing current limitations and exploring the wide application of DAT in different educational contexts.

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## CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial, or financial conflicts and declare the absence of conflicting interests with the funders.

## AUTHORS' CONTRIBUTIONS

Ban Jiandong carried out the research, wrote and revised the article, conceptualized the central research idea, and provided the theoretical framework. Yingsoon Goh designed the research. Ahmad Rithaudin Bin Md Noor supervised the research progress, anchored the review, and revisions, and approved the article submission.

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