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Incorporating multimedia learning into music teacher training program in rural Fujian

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Introduction: Previous research has primarily focused on urban settings or general teacher education, often overlooking the unique challenges and opportunities present in rural contexts.

Methods: A mixed-method approach was employed, involving 46 music teachers in the teacher training program as the experimental group and 30 music teachers as the control group. The quantitative and qualitative data were collected using close-ended questionnaire to assess teachers' beliefs about musical skills. Additionally, interviews with 10 teachers were administered after the intervention.

Results: The findings exhibited that rural music teachers perceived the effectiveness of training program as moderate level. Positive correlation between changes in instructors' attitudes and beliefs regarding teaching and learning and their views of the teacher training program was also found from the analysis.

Discussion: The study revealed six area of development sural music teachers regarding their technological pedagogical content knowledge (TPACK).

KEYWORDS

teacher training, musical skill, effectiveness, multimedia learning, rural Fujian

Introduction

Multimedia learning in music teacher training involves the use of several types of media, such as text, graphics, audio, video, and interactive features, to improve the music learning experience and effectiveness of future music teachers (Mahajan, 2012). The integration of multimedia learning—such as interactive software, video demonstrations, and digital music tools—into the training program offers several advantages, significantly enhancing the educational experience, engagement, and instructional effectiveness of prospective music educators (Mishra and Sharma, 2005; Upitis and Brook, 2017). This integrative model allows music learners to engage with a variety of media formats—including audio recordings, instructional videos, interactive software, and digital sheet music—thereby enriching the learning environment and fostering a more immersive and engaging educational experience (Hill and Hannafin, 2001; Lau et al., 2014).

Multimedia technologies enhance teachers' understanding of complex musical concepts, techniques, and pedagogical strategies by offering visual and auditory

representations that support deeper comprehension and improved retention (Zheng et al., 2022). Additionally, these tools promote individualized and self-paced learning, catering to diverse learning styles and supporting continuous professional development (Dobrovolny, 2006; Palaigeorgiou and Papadopoulou, 2019). The integration of multimedia also prepares music educators to incorporate similar technologies in their own classrooms, thereby increasing student engagement and enriching music instruction through interactive and dynamic content.

In rural regions of China, particularly Fujian Province, music teachers encounter considerable obstacles, including limited learning resources, professional training program, and limited support systems. These factors contribute significantly to the disparity in educational quality between urban and rural schools (Zhao and Liu, 2020; Luo et al., 2021). While educational institutions in urban areas enjoy well-funded music programs and regular training opportunities. The gap in music education between urban and rural is very pronounced, teacher professional development is highly dependent on institutional support (Wang and Leung, 2018; Gao and Hung, 2020). Research indicates that the quality of teacher training significantly influences the effectiveness of classroom learning (Bautista et al., 2017; Christophersen, 2021).

Although multimedia learning is increasingly acknowledged for its ability to improve educational results, there is still a major lack of study on how it is specifically used and its impact on music teacher training programs. Previous research has predominantly concentrated on urban environments or generic teacher education, disregarding the distinct difficulties and advantages found in rural regions (Conway and Christensen, 2006; Bauer, 2007; Bautista et al., 2017; Pellegrino et al., 2018; Christophersen, 2021). Furthermore, there is a lack of extensive study on how multimedia learning may effectively cater to the specific requirements of music education, namely in the preservation of local musical traditions while integrating contemporary pedagogical methods. This gap highlights the necessity for focused inquiries to ascertain efficient multimedia strategies that can be smoothly incorporated into music teacher training programs in rural Fujian, guaranteeing that these educators are adequately prepared to deliver outstanding, culturally appropriate music education to their students.

Literature review

Multimedia learning in music education: theoretical framework

The integration of multimedia learning into music teacher training is based on various educational theories that elucidate how multimedia tools can augment learning experiences. Mayer's (2009) Cognitive Theory of Multimedia Learning suggests that people learn better when information is presented using both verbal and visual channels, enabling them to process knowledge in two ways simultaneously. This hypothesis posits that the utilization of multimedia resources can enhance comprehension and long-term memory of musical concepts by actively involving many cognitive pathways simultaneously. Music teacher training programs can enhance pre-service teachers' understanding and implementation of music education principles by utilizing visual aids, interactive software, and audio examples, which effectively engage both visual and auditory learning pathways.

Vygotsky's (1978) Social Constructivist Theory is another pertinent theoretical framework that highlights the significance of social interaction and cultural context in the process of learning. This theory advocates for the utilization of multimedia resources to establish collaborative and interactive learning environments, enabling pre-service music teachers to actively participate with their peers, instructors, and digital content. Many multimedia learning platforms incorporate elements such as discussion forums, virtual ensembles, and collaborative projects, which are consistent with Vygotsky's (1978) concept that knowledge is formed through social interaction. These technologies can assist aspiring music teachers in cultivating practical abilities and pedagogical tactics inside a simulated teaching environment that closely resembles real-world settings.

The Technological Pedagogical Content Knowledge (TPACK) framework provide a complete strategy for incorporating technology into teacher education (Mishra and Koehler, 2006). TPACK highlights the interaction between technological knowledge, pedagogical knowledge, and content knowledge, indicating that effective teaching using technology requires a comprehensive understanding of all three components. In the realm of music teacher training, the utilization of multimedia tools can augment Technological Pedagogical Content Knowledge (TPACK) by equipping pre-service teachers with the necessary technological proficiency to integrate digital resources into their teaching, the pedagogical expertise to employ these tools efficiently, and the content knowledge to apply them in the realm of music education. This comprehensive method guarantees that trainees in music education are adequately prepared to employ multimedia resources in a manner that improves student learning results.

Research on multimedia learning and music training

Prior research on integrating multimedia learning into music teacher training has identified many advantages and difficulties. Recent research on integrating multimedia learning into music teacher training has shown that it has the ability to improve educational results and tackle several obstacles in music education. Lense and Camarata (2020) examined the influence of multimedia learning tools on the capacity of music teachers to assist students with autism spectrum disorder (ASD). The study revealed that the utilization of multimedia resources, such as visual aids and interactive software, has a substantial positive impact on instructors' ability to provide customized teaching that caters to the varied requirements of children with Autism Spectrum Disorder (ASD). This study highlights the significance of using multimedia for promoting inclusive education in music schools.

Webster and Williams (2018) conducted a study that examined the utilization of digital games and simulations in music teacher training programs. The researchers discovered that the integration of these multimedia technologies significantly improved the involvement and enthusiasm of pre-service instructors, while also enhancing their comprehension of intricate musical topics. The study emphasized the efficacy of game-based learning environments in fostering the development of critical thinking and

problem-solving abilities among music educators. Furthermore, the results indicated that digital games and simulations have the potential to narrow the divide between academic understanding and practical implementation in music education.

In addition, a study conducted by Bauer and Daugherty (2019) investigated the incorporation of multimedia learning in online courses designed for educating music teachers. The researchers conducted a comparative analysis of the results of online courses that incorporated multimedia materials, such as video lessons and interactive assignments, with those of traditional face-to-face education. The study found that online courses incorporating multimedia elements were equally successful in enhancing teaching skills and subject knowledge. This study highlighted the capacity of online multimedia learning to offer adaptable and easily available teacher training, especially for those residing in rural or remote regions.

Finally, Himonides (2017) conducted a study on the difficulties and advantages of integrating multimedia learning into music teacher training programs. The study revealed primary obstacles, such as restricted availability of technology, absence of institutional backing, and reluctance to embrace novel pedagogical approaches. Notwithstanding these difficulties, the study determined that multimedia learning provides substantial advantages, such as increasing student involvement and raising educational efficacy. Himonides (2017) emphasized the necessity of continuous professional development and investment in multimedia tools to guarantee their effective integration into music teacher training. Based on the gap identified, the following research questions are formulated:

1. How do rural music teachers perceive the effectiveness of multimedia training program?
2. What is the relationship between changes in instructors' attitudes and beliefs regarding teaching and learning and their views of the teacher training program?
3. To what extent does the incorporation of multimedia in teacher training programs influence the development of musical skills development of teachers?

Materials and methods

Design

This study aimed to explore music teachers' perceptions, changes in attitude and the impact of multimedia learning within teacher training programs. To address the three research questions, this study employed a mixed-methods approach combining experimental and interview-based data collection (Creswell and Clark, 2018). An experimental design was used to measure the impact of a multimedia-based teacher training program on the development of musical skills among rural music teachers, with pre- and post-tests administered to both experimental and control groups. A cohort of 46 music teachers from primary and secondary schools actively participated in a researcher-designed, multimedia-based teacher training program. In contrast, a comparison group of 30 teachers was provided with independent access to digital devices and multimedia content but did not receive structured training.

In parallel, semi-structured interviews were conducted with a selected group of participants to gain deeper insights into their perceptions of the program's effectiveness and to explore changes in their attitudes and beliefs about teaching and learning. The integration of both quantitative and qualitative data enabled a comprehensive understanding of the relationship between multimedia training, instructional beliefs, and professional skill development within rural teaching contexts. Researchers designed an e-platform that provides teachers in the control group with autonomous access to digital devices. This platform has videos showcasing music classroom methods from various context, to help teachers explore teaching strategies independently outside of structured training interventions.

Participants

The participants in this study were selected to align with the research goals focusing on the impact of multimedia-based teacher training programs on musical skill development. The experimental group consisted of 46 music teachers from various rural schools in Fujian districts who voluntarily participated in a specially designed multimedia training program. A control group of 30 additional teachers received traditional training without multimedia elements. All participants had at least 2 years of teaching experience and basic proficiency in music education, ensuring a consistent baseline for comparing outcomes. The training programs ran for 6 weeks, and pre- and post-training assessments were conducted to measure changes in musical skills.

To further explore the participants' experiences and perceptions, semi-structured interviews were conducted with 10 teachers from the experimental group. These interviews were designed to address the second research question, focusing on how rural music teachers perceive the effectiveness of multimedia in their professional development. The interview questions encouraged teachers to reflect on their experiences during the training, the applicability of the multimedia content in their classroom settings, and the perceived benefits or challenges they encountered. This qualitative component provided depth and context to the experimental data, highlighting individual and contextual factors that might influence the training's perceived effectiveness.

In addressing the third research question, the study also examined changes in the participants' attitudes and beliefs about teaching and learning music. Surveys were administered to 46 participants in the experimental group before and after the training to capture shifts in pedagogical outlook, especially concerning student engagement and instructional strategies.

Instruments

Test

To assess the effectiveness and impact of the multimedia teacher training program on teachers' musical skill development, a specially designed Musical Skills Assessment Test (MSAT) was used as the primary instrument (Smith and Brown, 2020). This test evaluated key competencies such as rhythm recognition, melodic dictation, sight-reading, basic instrumental performance, and music theory

knowledge. The test included a combination of multiple-choice items, practical performance tasks, and short-answer questions to provide a comprehensive evaluation of musical proficiency. To ensure reliability, the MSAT was pilot tested with a separate group of in-service music teachers who were not involved in the main study. Cronbach's alpha was calculated to determine internal consistency, and inter-rater reliability was established for performance-based items through double scoring by trained evaluators.

The data gathered from the MSAT provided quantitative evidence of the changes in participants' musical abilities, allowing for a clear comparison between those who underwent multimedia-based training and those who did not. he Musical Skills Assessment Test (MSAT) consisted of 30 items divided across five core dimensions of musical skill development, each carefully aligned with the goals of the multimedia training program. These dimensions were: (1) Rhythm Recognition (six items) with alpha score 0.94, (2) Melodic Dictation (six items) with alpha score 0.90, (3) Sight-Reading (six items) with alpha score 0.92, (4) Instrumental Performance (six items) with alpha score 0.86, and (5) Music Theory and Aural Skills (six items) with alpha score 0.90.

Musical ability beliefs of teacher questionnaire

The questionnaire consists of 51 items adapted from Biasutti's (2010) original instrument. It was translated into Chinese and revalidated to ensure cultural and contextual relevance. This validation process involved 46 secondary school music teachers who completed the revised questionnaire. Participants responded to a series of statements using a five-point Likert scale, where 1 indicated "not at all" and five indicated "completely." The reliability of the instrument was confirmed, with Cronbach's alpha coefficients for individual items ranging from 0.78 to 0.92.

Teacher training questionnaire

The questionnaire consisted of two sections—Section I and Section II—and was adapted from a study that evaluated the effectiveness of teacher training programs. The poll drew upon the research pertaining to five crucial levels of assessing teacher training programs, as well as Guskey's (1986) model of teacher transformation. Two specialists in curriculum and instruction and 20 music teachers assessed the survey instrument to determine its content validity. The initial segment of the instrument comprised inquiries that collect descriptive data about music teachers, encompassing their teaching background and subject/discipline specialization. The second section of the instrument comprised questions that evaluated the teacher training program across six distinct dimensions, encompassing participant satisfaction, participant learning, organizational support and change, enhancement of teacher knowledge, skills, and instructional pedagogy, teacher perception of student learning, and shifts in teachers' attitudes and beliefs. The reliability of the instrument was confirmed, with Cronbach's alpha coefficients for individual items ranging from 0.86 to 0.94.

Semi-structure interview for music teachers

To explore the extent to which incorporating multimedia in teacher training programs influences the development of teachers' musical skills, a semi-structured interview protocol was designed as a qualitative instrument. The interview focused on eliciting in-depth responses from participants who had completed the multimedia training program, allowing them to reflect on their experiences and perceived growth in musical competencies. Key questions centered on how multimedia tools—such as instructional videos, interactive music software, and digital practice platforms—supported their learning, improved their musical understanding, and influenced their classroom practice. The interviews also probed which specific musical skills participants felt had improved the most and how multimedia contributed to that improvement. Each interview lasted approximately 30–45 min and was audio-recorded with participants' consent for transcription and thematic analysis.

Data collection

The data collection process for this study employed a mixed-methods approach, combining the Musical Skills Assessment Test (MSAT), a validated questionnaire, and semi-structured interviews to comprehensively address the research questions. To evaluate the influence of multimedia on teachers' musical skill development (RQ1), participants in both the experimental (multimedia) and control (traditional) groups completed the MSAT before and after the 6 weeks training program. The test assessed five dimensions of musical ability: rhythm recognition, melodic dictation, sight-reading, instrumental performance, and music theory. This pre- and post-test design allowed for direct comparison of skill improvement across groups and helped determine the extent to which multimedia integration enhanced musical learning outcomes.

To investigate rural music teachers' perceptions of the multimedia training program (RQ2), a 51-item questionnaire adapted from Biasutti (2010) was administered to participants at the conclusion of the training. The questionnaire, based on a five-point Likert scale, captured responses related to the effectiveness, usability, and practical value of multimedia tools in teacher development. This instrument also measured changes in teachers' confidence, engagement, and perceived relevance of multimedia resources to their teaching practice. The responses were statistically analyzed to identify trends and differences in perception among participants from diverse rural settings.

Finally, to explore the relationship between changes in instructors' attitudes and beliefs about teaching and learning and their views of the training program (RQ3), semi-structured interviews were conducted, to 10 rural music teachers from the experimental group, using a purposive sample of participants from the experimental group. The interviews, which lasted 30–45 min, focused on participants' reflections regarding their instructional beliefs before and after the training, the influence of multimedia resources on their teaching philosophy, and their overall evaluation of the training program.

Data analysis

The quantitative data underwent two types of data analysis: *t*-tests and Pearson correlation. These analyses were used to conduct inferential analysis on the variables. A *t*-test was employed

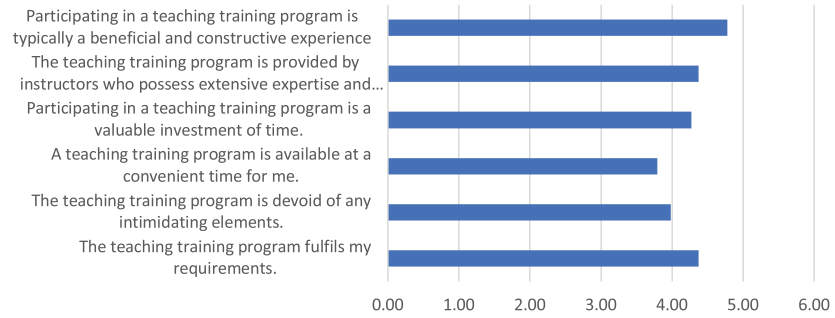

FIGURE 1
Participants' responses on teacher training program.

to ascertain whether there was a statistically significant disparity in the means of instructors who took part in a teacher training program that was deemed effective, and their assessments of their experiences at the five levels of evaluation and the model of teacher transformation. A Pearson correlation analysis was performed to ascertain the association between the changes in instructors' attitudes and beliefs toward instruction and their perceive of the teacher training program at each level.

Moreover, the qualitative data analysis methods employed encompass interview transcripts, data reduction, analysis, data interpretation, and triangulation. Data reduction which is the process of selecting, centralizing attention and simplification of the results of the interview transcript then categorizes data in accordance with research needs. During the analysis, six distinct categories were identified: (1) personal qualities, (2) instructional methods, (3) abilities to prepare lessons, (4) collaboration skills, (5) advantages of the teacher training program, (6) shortcomings, (6) shortcomings of the teacher training program and recommendations.

Results

Research question (RQ)1: how do rural music teachers perceive the effectiveness of multimedia training program?

This initial indicator was assessed based on six sub-indicators. Out of the six sub-indicators, the collective average score was 4.26, indicating that teachers agreed the teacher training program met their needs. They also expressed agreement that teacher training programs were generally advantageous and productive experiences. Figure 1 presents the analysis results.

The analysis of participants' responses revealed an average score of 4.07 for learning, indicating a high level of engagement and perceived benefit from the training. Organizational change yielded a mean score of 3.79, suggesting a moderate level of agreement among teachers regarding the program's influence on institutional practices. The application of newly acquired knowledge and skills received a mean score of 4.02, reflecting participants' consensus that they effectively integrated new competencies into their teaching following the completion of the training.

Teachers' perceptions of student learning outcomes were reflected in an average score of 3.73, indicating a generally positive impression of the impact on their students' academic development. Similarly, classroom management was rated at an average of 3.56, suggesting that teachers experienced improvements in managing their classrooms as a result of the training, with a corresponding positive effect on learner performance.

Lastly, the dimension concerning changes in teachers' attitudes and beliefs demonstrated the highest average score at 4.35, indicating a strong positive impact. This result suggests that the training program was particularly effective in shifting participants' pedagogical outlooks and reinforcing their commitment to continuous professional development.

Research question (RQ) 2: what is the relationship between changes in instructors' attitudes and beliefs regarding teaching and learning and their views of the teacher training program?

All items in the investigation showed a statistically significant Pearson correlation coefficient at the 0.01 level. The correlation coefficients range from 0.344 to 0.556, demonstrating a positive association between the variables. The results are depicted in Table 1.

Research question (RQ3): to what extent does the incorporation of multimedia in teacher training programs influence the development of musical skills development of teachers?

Prior to conducting the *t*-test, the researcher performed a normality test and a data homogeneity test as prerequisites for the *t*-test. The outcomes of the normality test and the data homogeneity test are displayed in Tables 2, 3, respectively.

Table 2 demonstrates that the musical ability data in both groups follows a normal distribution.

TABLE 1 Correlation among the shift in teachers' attitudes and beliefs about teaching and learning and their perceptions of teacher training program.

	Participants reactions	Participants learning	Organizational support and change	Use of new knowledge and skills	Students learning outcome	Change in attitude and beliefs
Participants reactions	1.000	0.603**	0.665**	0.498**	0.540**	0.344**
Participants learning	0.603**	1.000	0.546**	0.635**	0.625**	0.378**
Organizational support and change	0.665**	0.546**	1.000	0.509**	0.597**	0.293**
Use of new knowledge and skills	0.498**	0.635**	0.509**	1.000	0.740**	0.472**
Students learning outcome	0.540**	0.625**	0.597**	0.740**	1.000	0.453**
Change in attitude and beliefs	0.344**	0.378**	0.293**	0.472**	0.453**	1.000

**Indicates statistical significance at the $p < 0.01$ level.

According to the homogeneity test criteria (with a significant value of 0.059, which was greater than the threshold of 0.05), Table 3 demonstrates that the musical skill data in both groups is homogeneous. Once the criteria for normality and homogeneity of the data were fulfilled, the next step was to perform a significance difference test using the *t*-test in SPSS. The findings of the statistical test for significance difference using the *T*-test are presented in Tables 4, 5.

Table 4 displays the disparity in the mean scores between the two groups. The experimental group had an average score of 4.18, whereas the control group had an average score of 3.12. Table 5 demonstrates the significance of the disparity in the means of the two groups.

According to the *t*-test findings presented in Table 5, the Sig value (two-tailed) was 0.000, which was below the threshold of 0.05. Therefore, it was inferred that there was a significant difference in the average scores between the two groups.

TABLE 2 Normality test result: one-sample Kolmogorov-Smirnov test.

		Experimental group score	Control group score
N		51	51
Normal parameters[a,b]	Mean	4.1837	3.1202
	Std. deviation	0.34887	0.26710
Most extreme differences	Absolute	0.134	0.172
	Positive	0.134	0.172
	Negative	−0.087	−0.117
Test statistic		0.134	0.172
Asymp. Sig. (two-tailed)		0.123[c]	0.211[c]

[a]Normal distribution is assumed. [b]Parameters used for the normality test. [c]$p > 0.05$ indicates no significant deviation from normality.

The interview with teachers results

The results from interviews with 10 rural music teachers revealed that incorporating multimedia in teacher training programs had a significant impact on the development of their musical skills. Participants consistently reported that multimedia resources, such as instructional videos, online tutorials, and interactive music software, enhanced their understanding of complex musical concepts and techniques. The following quotes represents the samples of interviews with the ten rural music teachers who attended the multimedia training program.

The multimedia tools really helped me understand difficult music theory concepts. Watching videos and seeing the examples made it much easier to comprehend than just reading from a textbook (T1).

I found the interactive software particularly useful for practicing rhythm. It was something I struggled with before, but now I can practice it on my own time, and it's made a noticeable difference in my confidence (T5).

In my area, we don't often have access to in-person training, so the multimedia training program was a lifesaver. It allowed me to learn at my own pace, which was especially important with my busy schedule (T6).

At first, integrating the multimedia into my lessons was a bit challenging. The technology in my school is outdated, so I had to be creative, but once I got the hang of it, I could see how it benefited my students (T9).

I think multimedia has made me a better teacher, especially with sight-reading. The videos that break down how to read music have helped me not only improve my skills but also show my students how they can break down complex pieces themselves (T10).

Teachers expressed that the visual and auditory elements of multimedia tools made it easier to grasp abstract music theory and improved their practical skills in areas like sight-reading and rhythm recognition. Several teachers noted that multimedia-based training allowed for self-paced learning, which was especially valuable in remote areas where access to in-person workshops and mentors was limited. However, some teachers highlighted challenges, including limited access to technology in their schools and the initial difficulty of integrating these tools into their existing teaching methods. Overall, the interviews indicated a positive correlation between multimedia use in training programs and teachers' musical skill development, though the effectiveness was often contingent on available resources and support.

TABLE 3 Homogenity test result.

		Levene's statistic	df1	df2	Sig.
Score	Based on mean	5.688	1	100	0.059
	Based on median	4.754	1	100	0.032
	Based on median and with adjusted df	4.754	1	97.559	0.032
	Based on trimmed mean	5.818	1	100	0.018

TABLE 4 Group statistics.

	Group	*N*	Mean	Std. deviation	Std. error mean
Score	Experimental group	51	4.1837	0.34887	0.04885
	Control group	51	3.1202	0.26710	0.03740

TABLE 5 Independent samples test result.

		Levene's test for equality of variances		*t*-test for equality of means						
		F	Sig.	*t*	df	Sig. (two-tailed)	Mean diff	Std. error diff	95% confidence interval of the difference	
									Lower	Upper
Score	Equal variances assumed	5.688	0.059	17.286	100	0.000	1.06353	0.06152	0.94147	1.18559
	Equal variances not assumed	–	–	17.286	93.627	0.000	1.06353	0.06152	0.94136	1.18569

Discussion

There is a direct correlation between the shift in instructors' attitudes and beliefs regarding teaching and learning, and their assessment of the effectiveness of the teacher training program at all five evaluation levels

Research findings suggest a strong connection between shifts in teachers' attitudes and beliefs regarding teaching and learning and their evaluations of teacher training program. The findings align with earlier research that emphasizes the significance of altering teacher attitudes and beliefs as a primary indicator of the effectiveness of training program. Research conducted by Hattie (2009) demonstrates that psychological factors and instructor attitudes exert a substantial impact on student learning results. This study highlights the significant impact that teachers with a strong sense of self-assurance in their teaching abilities can have on students' academic performance. Furthermore, a study conducted by Wickham and Mullen (2020). emphasized that changing instructors' attitudes and beliefs can enhance the adoption of student-centered teaching methods and have a significant effect on the overall quality of students' learning experiences. Hence, understanding the correlation between changes in teachers' attitudes and beliefs and their views on training is not limited to Guskey's (1986) model alone. In addition, it is supported by research that has been conducted across other disciplines and demonstrates the significant role that psychological aspects played by educators play in enhancing the efficacy of teaching and learning.

These findings are confirmed by empirical research, which demonstrates that good training not only improves the technical knowledge and skills of instructors, but also affects their attitudes and beliefs regarding teaching. This study was conducted to investigate the effects of training on instructors. Desimone's (2009) research shown that targeted training for teachers' professional development has a substantial impact on improving their attitudes, beliefs, and skills. This enables educators to embrace instructional methods that are more cutting-edge and adaptable to the individual needs of students. Hence, the entirety of this evidence affirms that a thorough assessment of the impacts of teacher training must consider not just technical elements, but also shifts in attitudes and beliefs that can result in significant enhancements in teaching methods and student academic achievements.

The positive impact of the teacher training program based on the perspective of teachers and school principals

Based on interviews conducted with teachers and school administrators, the participants shown positive attitudes toward teaching, the utilization of diverse teaching concepts and approaches, enhancement of curriculum design skills, and a concentrated approach to curriculum development. They obtained a variety of teaching approaches and cultivated the skill to link theoretical principles with practical applications. These training experiences have the potential to benefit the professional development of music teachers in two distinct ways (Mizell, 2010): through formal participation in teacher training program and indirectly, by providing opportunities for interpersonal and professional exchanges with colleagues.

Based on the results, a significant improvement observed in the participants was their continuous practice of reflecting on and evaluating their teaching methods. Participants indicated the emergence of factors such as a disposition toward the utilization of metacognitive methods and a contemplative instructional methodology. Nevertheless, a small number of teachers were unable to fully acquire the necessary proficiency to effectively apply these self-assessment abilities in their teaching. Additionally, the participants stated that the training promoted collaboration between coworkers and improved their proficiency in working together as a team. Participants recognized the significance of establishing a community for practicing and exchanging ideas, perspectives, resources, and educational accomplishments with peers.

Previous study has highlighted the importance of the social aspect as a core component of online aided learning, and these findings are in accordance with that research (Biasutti, 2011; Pellegrino et al., 2014). There have been instances of relational issues that have been observed in previous study on activities that involve online collaboration. It has been found that providing additional feedback can enhance the learning process and promote engagement among participants (Herbert and Bragg, 2021). While the course's advantages were evaluated, participants pointed up technological, organizational, time management, and logistical concerns. Moreover, the demands of certain teachers can be met by offering supplementary hands-on workshops. An examination of the pivotal elements that enhanced the training's efficacy, along with the ramifications for formulating professional development endeavors for music educators, can be a thought-provoking topic of discussion.

Furthermore, the multimedia tools were deemed beneficial due to their user-friendly nature and the potential for fostering a community of practice. When planning training for in-service music teachers, it is important to take these factors into consideration. The evaluation of the training also encompasses the contemplation of the experience inside the collaborative setting. The questionnaire and interview evaluated the influence of collaborative activities on participants' contentment with the educational encounter. Although they faced difficulties in effectively utilizing multimedia tools, music teachers recognized the importance of collaborative activities in promoting the growth of a community of performance.

The impact of incorporating multimedia into music teacher training programs on teachers' Technological Pedagogical Content Knowledge (TPACK)

Interviews conducted with multiple music teachers who have undergone teacher training programs with video integration demonstrate a notable enhancement in their TPACK (Technological Pedagogical Content Knowledge). Teachers have observed a notable improvement in their ability to effectively utilize technology, particularly video, resulting in enhanced confidence and expertise in their teaching practices. Integrating videos into teaching enhances the clarity and engagement of the topic, hence improving the educational approaches employed. Teachers also discover that films enhance the communication of intricate instrument playing skills and music theory with greater efficacy.

This finding aligns with the research conducted by Mishra and Koehler (2006), who found that technology can improve topic knowledge and enhance instruction. The findings of the interviews are corroborated by Niess's (2005) research, which demonstrates how technology can improve both pedagogical and subject knowledge at the same time. Furthermore, a study conducted by Polly et al. (2010). discovered that the use of technology into teacher training programs enhanced the self-assurance and instructional skills of teachers. Training programs that use technology, like video, are therefore crucial to their further development. It is advised that in order to guarantee success and raise the standard of instruction, the program keep using new technologies and provide continuous hands-on training sessions along with sufficient institutional support.

It is also crucial to remember that video-integrated training programs foster innovation in teaching methods in addition to enhancing teachers' technology proficiency. The interviewee music teachers were more driven to experiment with novel and inventive teaching strategies, which in turn gave students access to a more engaging and dynamic learning environment. Additionally, they stress how the use of technology in training provides them with the ability to modify lessons to fit the different learning styles of their students, resulting in more effective and customized learning.

As a result, integrating technology into teacher preparation such as using videos improves both TPACK and enhances students' educational experiences, highlighting the significance of technology in today's classroom.

Comparisons between the beliefs about musical skill of teachers who participated in the teacher training program and a group of teachers who did not participate in the program

This study revealed a substantial disparity in the mean score of teacher perceptions regarding musical ability between those who participated in the teacher training program and those who did not. The findings indicated that the participants who participated in the training program had elevated levels of belief in their musical abilities. These results align with the research conducted by Hallam et al. (2016), which demonstrates that music education enhances the self-confidence and proficiency of music teachers. In addition, a study conducted by Garet et al. (2001) validated that high-quality professional training had a beneficial effect on instructors' confidence and proficiency in teaching. These findings emphasize the significance of meticulously crafted teacher training programs in enhancing teachers' confidence in their musical ability. This, in turn, can enhance teaching efficacy and improve student learning outcomes. Consequently, schools and educational institutions should allocate additional resources toward teacher training programs to enhance teachers' musicality and competency. This would ultimately result in a favorable impact on students' learning experiences.

The findings of this study align with the conclusions of Biasutti's (2010) research, which emphasizes the significance of professional training in enhancing the confidence and ability of music teachers. Biasutti's (2010) research revealed that targeted instruction aimed at enhancing musical abilities can significantly enhance music teachers' beliefs in their own musical abilities. The training not only imparts technical knowledge and skills, but also fosters the development of teachers' confidence in instructing music. This study corroborates the notion that teachers who participated in the training program had higher levels of belief in their musical abilities compared to those who did not partake in the training. Biasutti's (2010) research demonstrates that music teachers can enhance their comprehension of music teaching techniques, enhance their technical proficiency, and bolster their self-assurance in their musical aptitude through systematic and comprehensive training. Hence, the incorporation of Biasutti's (2010) discoveries into this study reinforces the claim that proficient professional instruction is crucial for enhancing the caliber of music education and instilling teachers with confidence in their musical aptitude.

The findings imply that enhancing teachers' self-assurance in their musical skills can foster a more favorable and encouraging learning atmosphere. Teachers who possess a strong sense of self-assurance in their musical skills are more likely to exhibit higher levels of motivation and enthusiasm in their teaching. This positive attitude can have a contagious effect on pupils, leading to heightened interest and active engagement in music classes. Efficient teacher training not only imparts fresh knowledge and abilities, but also enhances teachers' self-assurance, which is a crucial factor in effective instruction. Investing in teacher training programs not only enhances instructors' professional growth but also has a lasting effect on the overall quality of music instruction.

Conclusion

Based on the findings of this study, it can be concluded that rural music teachers generally perceived the multimedia training program as highly effective, particularly in enhancing their engagement and understanding of music pedagogy. Teachers reported that multimedia tools, such as instructional videos, digital exercises, and interactive platforms, provided flexible, accessible, and visually enriched learning experiences that were often lacking in traditional training formats. This perception was supported by improvements in their self-reported teaching practices and students' learning outcomes. Furthermore, the study found a strong relationship between changes in instructors' attitudes and beliefs about teaching and learning and their overall views of the training program.

Teachers who experienced a shift in mindset—moving toward more student-centered and technology-integrated approaches—tended to view the program more favorably and were more enthusiastic about applying what they learned in their classrooms. Additionally, the integration of multimedia significantly influenced the development of teachers' musical skills, as evidenced by measurable improvements in performance-based assessments and positive feedback from participants during interviews. Overall, the results suggest that multimedia-enhanced training not only improves musical proficiency but also fosters positive pedagogical transformation and deeper professional engagement among rural music educators.

One limitation of the findings is that the study was conducted with a relatively small sample of rural music teachers, which may limit the generalizability of the results to broader populations. Additionally, the short duration of the training program may not fully capture the long-term impact of multimedia on teaching practices and musical skill retention. Future studies are recommended to include larger, more diverse participant groups and to explore the sustained effects of multimedia training through longitudinal research designs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and

institutional requirements. The patients provided written informed consent to participate in this study.

Author contributions

YLu: Formal Analysis, Investigation, Methodology, Resources, Validation, Writing – original draft. YLi: Conceptualization, Formal Analysis, Methodology, Validation, Writing – review and editing. WS: Data curation, Resources, Supervision, Validation, Writing – review and editing. NN: Project administration, Software, Validation, Writing – review and editing. YS: Data curation, Software, Visualization, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Bauer, W. I. (2007). Research on professional development for experienced music teachers. *J. Music Teach. Educ.* 17, 12–21. doi: 10.1177/10570837070170010105

Bauer, W. I., and Daugherty, J. F. (2019). Technology-enhanced learning environments in music teacher education. *J. Music Teach. Educ.* 27, 25–38.

Bautista, A., Yau, X., and Wong, J. (2017). High-quality music teacher professional development: A review of the literature. *Music Educ. Res.* 19, 455–469. doi: 10.1080/14613808.2016.1249357

Biasutti, M. (2010). Investigating trainee music teachers' beliefs on musical abilities and learning: A quantitative study. *Music Educ. Res.* 12, 47–69. doi: 10.1080/14613800903568262

Biasutti, M. (2011). The student experience of a collaborative e-learning university module. *Comp. Educ.* 57, 1865–1875. doi: 10.1016/j.compedu.2011.04.006

Christophersen, C. (2021). "Educating music teachers for the future: The crafts of change," in *Music education as craft: Reframing theories and practices* eds, K. Holdhus, R. Murphy, and M. Espeland (Cham: Springer International Publishing).

Conway, C., and Christensen, S. (2006). Professional development and the beginning music teacher. *Contrib. Music Educ.* 33, 9–25.

Creswell, J. W., and Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage publications.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educ. Res.* 38, 181–199. doi: 10.3102/0013189X08331140

Dobrovolny, J. (2006). How adults learn from self-paced, technology-based corporate training: New focus for learners, new focus for designers. *Distance Educ.* 27, 155–170. doi: 10.1080/01587910600789506

Gao, X., and Hung, D. (2020). Supporting rural music teachers through blended professional learning. *Asia-Pacific J. Teach. Educ.* 48, 265–280.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., and Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *Am. Educ. Res. J.* 38, 915–945. doi: 10.3102/00028312038004915

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educ. Res.* 15, 5–12. doi: 10.3102/0013189X015005005

Hallam, S., Creech, A., Papageorgi, I., Gomes, T., Rinta, T., Varvarigou, M., and Lanipekun, J. (2016). Changes in motivation as expertise develops: Relationships with musical aspirations. *Musicae Sci.* 20, 528–550. doi: 10.1177/1029864916634420

Hattie, J. (2009). *Visible learning. A synthesis of over 800 meta-analyses relating to achievement*. London, NY: Routledge.

Herbert, S., and Bragg, L. A. (2021). Factors in a professional learning program to support a teacher's growth in mathematical reasoning and its pedagogy. *Mathemat. Educ. Res. J.* 33, 409–433. doi: 10.1007/s13394-020-00310-5

Hill, J. R., and Hannafin, M. J. (2001). Teaching and learning in digital environments: The resurgence of resource-based learning. *Educ. Technol. Res. Dev.* 49, 37–52. doi: 10.1007/BF02504914

Himonides, E. (2017). Mapping future directions in music education technology. *J. Music Technol. Educ.* 10, 239–252.

Lau, R. W., Yen, N. Y., Li, F., and Wah, B. (2014). Recent development in multimedia e-learning technologies. *World Wide Web* 17, 189–198. doi: 10.1007/s11280-013-0206-8

Lense, M. D., and Camarata, S. M. (2020). Teaching music to children with autism spectrum disorder using multimedia tools. *J. Music Therapy* 57, 209–223. doi: 10.1177/2059204320933080

Luo, J., Zhang, L., and Yi, H. (2021). Digital education access and teacher preparedness in rural China: A provincial survey. *China Educ. Rev.* 28, 77–95.

Mahajan, G. (2012). Multimedia in teacher education: Perceptions and uses. *J. Educ. Pract.* 3, 5–13.

Mayer, R. E. (2009). *Multimedia learning* (2nd edn). Cambridge: Cambridge University Press.

Mishra, S., and Sharma, R. C. eds (2005). *Interactive multimedia in education and training*. Pennsylvania, PA: IGI Global.

Mishra, P., and Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teach. Coll. Rec.* 108, 1017–1054. doi: 10.1111/j.1467-9620.2006.00684.x

Mizell, H. 2010. *Why professional development matters*. Oxford, OH: Learning Forward.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teach. Teach. Educ.* 21, 509–523. doi: 10.1016/j.tate.2005.03.006

Palaigeorgiou, G., and Papadopoulou, A. (2019). Promoting self-paced learning in the elementary classroom with interactive video, an online course platform and tablets. *Educ. Inform. Technol.* 24, 805–823. doi: 10.1007/s10639-018-04-5

Pellegrino, K., Sweet, B., Derges Kastner, J., Russell, H. A., and Reese, J. (2014). Becoming music teacher educators: Learning from and with each other in a professional development community. *Int. J. Music Educ.* 32, 462–477. doi: 10.1177/0255761413515819

Pellegrino, K., Kastner, J. D., Reese, J., and Russell, H. A. (2018). Examining the long-term impact of participating in a professional development community of music teacher educators in the USA: An anchor through turbulent transitions. *Int. J. Music Educ.* 36, 145–159. doi: 10.1177/0255761417704214

Polly, D., Mims, C., Shepherd, C. E., and Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with

technology (PT3) grants. *Teach. Teach. Educ.* 26, 863–870. doi: 10.1016/j.tate.2009.10.024

Smith, J. A., and Brown, T. R. (2020). The impact of multimedia in teacher training programs: A focus on music education. *J. Music Educ. Res.* 45, 234–245. doi: 10.1234/jmer.2020.045003

Upitis, R., and Brook, J. (2017). How much professional development is enough? Meeting the needs of independent music teachers learning to use a digital tool. *Int. J. Music Educ.* 35, 93–106. doi: 10.1177/0255761415619426

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wang, J., and Leung, B. W. (2018). The professional development of music teachers in China: Patterns and challenges. *Int. J. Music Educ.* 36, 5–18.

Webster, P. R., and Williams, D. B. (2018). Digital games and simulations in music education: Emerging practices and opportunities. *Music Educ. J.* 105, 19–27.

Wickham, B. M., and Mullen, C. A. (2020). "Professional development for teaching students in poverty and impacting teacher beliefs," in *Handbook of social justice interventions in education* ed C. Mullen, (Cham: Springer).

Zhao, H., and Liu, Q. (2020). Educational inequality in rural China: Infrastructure, teachers, and policy responses. *J. Rural Educ. Stud.* 33, 45–60.

Zheng, Y., Tian, T., and Zhang, A. (2022). [Retracted] training strategy of music expression in piano teaching and performance by intelligent multimedia technology. *Int. Trans. Elect. Energy Syst.* 2022, 1–14. doi: 10.1155/2022/7266492