INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 15, Issue 2, (2026) E-ISSN: 2226-6348

Research on the Reconstruction Strategies and Practical Paths of the Professional Development Support System for College Music Teachers under the Context of Digital Intelligence Enabling Forces

Wei Wang

Hanshan Normal University

DOI Link: http://dx.doi.org/10.6007/IJARPED/v15-i2/28016

Published Online: 25 April 2026

Abstract

This study takes Hanshan Normal University as the research sample and uses the questionnaire survey method to investigate 126 in-service teachers from the music college and related departments. Descriptive statistics, Pearson correlation analysis, multiple linear regression analysis, and independent sample t-tests are employed as quantitative research methods to systematically examine the current situation, pain points, and the need for reconfiguration of the support system for the professional development of music teachers in universities under the context of digital and intelligent empowerment. The research results show that the overall application ability of digital and intelligent technologies by music teachers is relatively weak ($M = 2.87$, $SD = 0.73$), and the satisfaction level of the professional development support system is at a moderately low level; the integration ability of digital and intelligent technologies, the level of institutional guarantee, and the sense of professional development efficacy of teachers are significantly positively correlated ($r = 0.612$, $r = 0.589$, $p < 0.01$); the multiple regression analysis indicates that the frequency of technical training, peer collaboration support, and policy incentive mechanisms have significant positive predictive effects on the sense of professional development efficacy (adjusted $R^2 = 0.487$). Based on this, this paper proposes strategies and practical paths for the reconfiguration of the support system from three dimensions: technology empowerment platform construction, optimization of institutional guarantee mechanisms, and the construction of collaborative learning communities, with the aim of providing empirical references for similar local universities.

Keywords: Digital And Intelligent Empowerment, Music Teachers in Universities, Professional Development Support System, Reconfiguration, Practice Path

Introduction

With the rapid development of new-generation information technologies such as artificial intelligence, big data, and cloud computing, "digitalization" is profoundly reshaping the ecological pattern of higher education. The "Education Informatization 2.0 Action Plan" issued by the Ministry of Education and a series of digital transformation policy documents

clearly require higher education institutions to accelerate the process of educational digitalization and effectively enhance teachers' information literacy and digital teaching capabilities. Against this backdrop, university music teachers, as important inheritors of art education, are facing the dual pressures and transformation challenges of integrating traditional teaching paradigms with digital technologies.

However, compared with science and engineering majors as well as comprehensive teacher education programs, the professional development of music teachers has long been centered around the improvement of performance skills and the accumulation of academic research. Their acceptance and application of digital and intelligent technologies have lagged behind. At the same time, the construction of a professional development support system for music teachers lacks systematic planning. Problems such as the disconnection between technical training content and actual teaching situations, incomplete incentive mechanisms, and weak collaborative development networks are widespread.

Hanshan Normal University is located in Chaozhou City, Guangdong Province. It is the only undergraduate normal university in the eastern part of Guangdong Province. Its School of Music undertakes an important mission of serving the basic education in the eastern region. Driven by the policy of regional educational digital transformation, the professional development of music teachers at this university is facing a situation where both opportunities and challenges coexist. This study takes Hanshan Normal University as a typical case and uses quantitative research methods to systematically measure the current situation of music teachers' professional development under the background of digital empowerment, analyze the key factors that affect their sense of professional development efficacy, and propose strategies and practical paths for the reconfiguration of the support system, with the aim of providing reference for similar local universities.

Literature Review

Theoretical Origin and Research Progress of Teacher Professional Development Support System

The concept of teacher professional development has gradually entered the academic realm since the 1970s and has continuously enriched its connotation with the deepening of educational reform practices. Early studies equated teacher professional development with "in-service training", focusing on a linear model of knowledge supplementation and skill acquisition (Joyce & Showers, 1980), with teachers in a subordinate position of passively accepting external knowledge delivery. In the 1980s, with the rise of reflective practice theory, Schön (1983) proposed that the core of teacher professional growth lies in "reflecting in action" and "reflecting on action", shifting professional development from the technical rational paradigm to the practical cognitive paradigm, emphasizing the subjective position of teachers as active constructors. Domestic scholar Ye Lan (2001) on this basis proposed that teacher professional development should achieve a fundamental transformation from "knowledge replenishment type" to "practical reflection type", and further expanded it into the development concept of "life consciousness", advocating the integration of teacher professional growth with the overall pursuit of life meaning, profoundly influencing the theoretical direction of teacher professional development research in China. Fullan (2007) from the perspective of system change, placed teacher professional development within the macro framework of school overall improvement, believing that sustainable professional

development must be embedded in teachers' daily practice rather than relying on short-term training outside the context. This view echoes Day's (1999) concept of "continuing professional development" (CPD), jointly emphasizing the systematicness, continuity, and context embedding of professional development. At the structural framework level of the support system, existing research generally believes that it covers three levels: macro system, meso organization, and micro interaction. At the macro level, since 1993 when the "Teacher Law" was promulgated in China, a series of documents such as "Teacher Professional Standards" (2012), "Education Informatization 2.0 Action Plan" (2018), and "Industry Standard for Teacher Digital Literacy" (2022) have been successively issued, gradually building a teacher professional development policy framework with Chinese characteristics; at the meso level, Wang Jiayi and Chang Baoning (2010) pointed out that the core elements of the support system for university teachers' professional development include systematic training programs, complete incentive and guarantee systems, and scientific developmental evaluation systems; Guskey (2002) proposed a five-layer assessment model including participants' reactions, learning, organizational support, behavioral change, and student learning outcomes; at the micro level, Wenger's (1998) "practical community" theory and Hargreaves and Fullan's (2012) concept of "professional capital" both emphasize the key value of peer collaboration and collective wisdom, believing that social support plays an indispensable role in the formation of teachers' professional efficacy. Regarding the correlation between satisfaction with the support system and efficacy, Bandura's (1997) self-efficacy theory and Tschannen-Moran and Woolfolk Hoy's (2001) empirical research both indicate that organizational support level is an important external variable for predicting teachers' self-efficacy, and domestic researcher Xin Tao and Jiang Yu's (2014) research further confirmed that the completeness of institutional incentives, the targetedness of training content, and the support attitude of management are key institutional factors affecting the efficacy of university teachers' professional development.

Research Framework on Digital and Intelligent Technologies Empowering Teachers' Professional Development

"Digital intelligence technology" refers to the comprehensive integration of digital technology and artificial intelligence technology. Its core feature lies in achieving precise perception, dynamic analysis, and personalized intervention of the educational process through intelligent algorithms driven by big data. Typical application forms include intelligent learning management systems, learning analysis platforms, adaptive learning systems, intelligent tutoring systems, and generative AI teaching assistants, etc. The "connectivist" learning theory proposed by Siemens (2013) provides an important theoretical foundation for empowering teachers' professional development with digital intelligence technology. It holds that in the digital network era, knowledge is distributed among complex network nodes formed by people and machines, and the essence of learning lies in the establishment of connections between nodes. This perspective provides a powerful explanatory framework for understanding the new form of teacher professional learning under the condition of digital intelligence empowerment. In terms of empowerment mechanisms, existing research has revealed the role paths of digital intelligence technology from multiple aspects: At the personalized support level, the intelligent learning analysis system can accurately diagnose the teacher's capability weaknesses based on their learning behavior data, achieving a transformation from "mass irrigation" to "precise drip irrigation" of support (Zhu Zhiting, 2022); At the real-time feedback level, digital intelligence technology can capture and

dynamically feedback the teacher's teaching behavior, breaking the time lag predicament of traditional reflection relying on post-observation (Luckin et al., 2016); At the collaborative sharing level, the digital platform breaks the time and space limitations, enabling cross-regional teacher learning communities to operate efficiently, significantly expanding the boundaries of knowledge flow (Dede et al., 2009). Peng Hongchao and Zhu Zhiting (2021) proposed a precise teaching and generative model of instructional generation under the framework of "smart education", emphasizing the crucial significance of the data-driven teaching improvement cycle for teachers' professional growth. However, the structural gap between technology supply and teachers' actual application has always been a core issue continuously focused on by various studies. Davis (1989) proposed the Technology Acceptance Model (TAM), which holds that perceived usefulness and perceived ease of use are the two core factors determining an individual's willingness to accept technology, and Tondeur et al. (2017) further discovered that there is a complex interaction among technology acceptance willingness, institutional support, and teachers' digital literacy, jointly influencing the empowerment effect of digital intelligence technology. Yu Shengquan (2020) pointed out that there is a significant "technology anxiety" phenomenon among university teachers in the application of technology, manifested as psychological rejection of the risk of technology 失控 and path dependence on traditional teaching models， which is particularly prominent among teachers in the humanities and arts. Mishra and Koehler (2006) proposed the Knowledge Framework of Integrating Technology into Subject Teaching (TPACK) from the perspective of knowledge structure， indicating that teachers' effective integration of technology depends on the deep integration of subject content knowledge， teaching method knowledge， and technology knowledge， rather than the mastery of a single tool， which has important implications for the systematic design of training content in the support system.

The Specificity of Professional Development of College Music Teachers and Current Research Status

Compared with teachers in other disciplines, the professional development of music teachers has distinct characteristics of practicality, individuality and physicality. Mark (2014) pointed out that the continuous improvement of performance skills, the deepening of artistic aesthetic ability and the iterative update of music teaching methods constitute the three main lines of music teachers' professional development, which are interwoven and mutually reinforcing. This highly dependent on physical perception and emotional experience disciplinary attribute makes the professional development of music teachers difficult to be fully achieved through explicit knowledge transmission, and more relies on apprenticeship teaching, demonstration learning and long-term practical accumulation. Regelski (2002) from the perspective of critical practice theory pointed out that there has been a long-term "aestheticism" tendency in the field of music education, attributing teaching value to pure aesthetic experience while neglecting its social practice attributes, which to a certain extent has solidified music teachers' psychological resistance to technical intervention; while Elliott and Silverman (2015) within the philosophical framework of "action music education" advocated that music teachers should regard digital technology as an important means to expand teaching space and deepen students' music experience, rather than alienating and undermining the essence of music, providing theoretical support for music teachers to re-examine the educational value of digital technology. In terms of the professional development content dimension, Bauer (2014) believed that music teachers' professional

development covers four core areas: update of performance skills, deepening of academic knowledge of music theory and music history, accumulation of music education theory, and ability to develop courses and design teaching. And emerging technical abilities such as digital audio production (DAW), online teaching platform operation and virtual instrument teaching are gradually becoming important components of music teachers' professional qualities. In terms of domestic research, the concern for the professional development of university music teachers has gradually emerged since the early 21st century. Early research mostly focused on the theoretical construction of professional development content framework and path model (Guan Jianhua, 2005; Xie Jiaxing, 2007). After entering the information age, some scholars began to pay attention to multimedia teaching and the application of digital music technology in the classroom (Li Fangyuan, 2012; Liu Pei, 2015). In recent years, Zhang Lu (2020) through a questionnaire survey found that the overall level of online teaching ability of university music teachers is at a medium-low level, and the ability to build online courses and develop digital resources is particularly weak; Wang Xiaoyan (2021) from the perspective of digital literacy pointed out that current university music teachers have different degrees of development bottlenecks in three dimensions: application of technical tools, data awareness and digital innovation ability; Chen Yaxian (2022) further revealed that music teachers from local normal universities, due to relatively limited access to regional resources, have significant structural differences in digital technology application ability and professional development support system compared with key universities, and require differentiated policy intervention. In the international reference aspect, the National Music Education Association of the United States (NAfME) has established a diversified professional development support ecosystem covering on-the-job training, academic conferences, peer networks and digital resource libraries, the "continuous professional development program" implemented by the Royal College of Music in the UK combines project-based training and personalized mentor guidance, and the Finnish Sibelius Music College has explored the construction of a professional development culture of "teachers as researchers", the above international experiences jointly indicate that an effective professional development support system for music teachers must take into account the organic integration of technical ability improvement, disciplinary cultural identity and institutional guarantee, and the training content must be deeply integrated with the specific teaching context of the music discipline to achieve an effective leap from technical acquisition to teaching transformation.

Review of Previous Studies and the Entry Point of This Research

Based on the review of the above literature, it can be observed that the current research has accumulated a relatively rich body of knowledge in three aspects: the theoretical framework and structural elements of the teacher professional development support system have become increasingly clear; the mechanism and influencing factors of digital technology enabling teacher professional development have been systematically revealed; and the disciplinary particularity and practical difficulties of university music teachers' professional development have also received initial attention. However, when reviewing the existing research, several research gaps worthy of in-depth exploration can still be identified. Firstly, the existing research rarely integrates the three elements of digital technology enabling, professional development support system, and teacher efficacy into a unified analytical framework for comprehensive quantitative testing, and the relative weights and interaction mechanisms among the influencing factors remain to be clarified. Secondly, empirical research on music teachers in local normal universities, a specific group, is extremely scarce.

The external validity of the existing conclusions is questionable, and it is difficult to provide specific empirical references for the support system construction of similar institutions. Thirdly, the existing research mostly stays at the level of problem diagnosis. There is still a gap in research that proposes systematic and highly operational practical paths from the perspective of the overall reconstruction of the support system, and the connection between theoretical research and practical transformation is relatively obvious. Fourthly, the differentiated needs of teachers of different genders, professional titles, and teaching years in professional development-related dimensions have not been fully demonstrated through empirical research, and the precise design of the support system lacks the necessary data basis. In view of this, motivated by the urgent need to bridge the structural gap between digital technology supply and the actual professional development demands of music teachers in local normal universities, and driven by the lack of empirical research that integrates technology empowerment, support systems, and teacher efficacy into a unified analytical framework. this study takes Hanshan Normal University as a typical sample, focuses on the practical difficulties of university music teachers' professional development in the context of digital technology empowerment, and comprehensively uses descriptive statistics, correlation analysis, multiple regression, and difference tests as quantitative research methods to systematically examine the key influencing factors of professional development efficacy, and on this basis, proposes integrated strategies and practical paths for the reconstruction of the support system, aiming to fill the above research gaps in both theoretical construction and practical guidance, and provide valuable empirical evidence and policy implications for the teacher professional development work of similar local universities.The primary contribution of this study lies in its provision of a quantifiable empirical basis for restructuring the professional development support system for music teachers in local normal universities, and in its identification of the differentiated needs across teacher subgroups—such as gender, professional title, and teaching experience—thereby offering actionable insights for precision-oriented policy design.

Research Design and Methods

Research Participants

This study focused on the in-service teachers of the Music Department of Hanshan Normal University and related public music courses. Using cluster sampling combined with voluntary participation, a total of 140 questionnaires were distributed, and 126 valid questionnaires were retrieved, with an effective recovery rate of 90.0%. The basic characteristics of the sample are as follows: In terms of gender, there were 48 male teachers (38.1%) and 78 female teachers (61.9%); in terms of age, 34 teachers were between 25 and 35 years old (27.0%), 57 teachers were between 36 and 45 years old (45.2%), and 35 teachers were 46 years old or above (27.8%); in terms of professional title, 52 teachers were assistants/lecturers (41.3%), 47 teachers were associate professors (37.3%), and 27 teachers were professors (21.4%); in terms of teaching experience, 21 teachers had less than 5 years of experience (16.7%), 63 teachers had 5 to 15 years of experience (50.0%), and 42 teachers had more than 15 years of experience (33.3%); in terms of education level, 79 teachers had a master's degree (62.7%), 39 teachers had a doctorate (31.0%), and 8 teachers had a bachelor's degree (6.3%).

Research Instruments

This study adopted a self-developed "Questionnaire on Professional Development of Music Teachers in the Context of Digital and Intelligent Empowerment" and adapted and localized it based on mature tools such as Bandura's (1997) Self-Efficacy Scale, Teacher Information Technology Application Ability Assessment Framework (Ministry of Education, 2022), and TPACK Scale. The questionnaire included five core dimensions: First, digital and intelligent technology cognition and application ability (8 items), measuring the teachers' understanding of digital and intelligent technologies and the frequency and depth of their application in teaching; second, satisfaction with the professional development support system (10 items), evaluating the satisfaction with existing training, systems, and resources; third, participation in technical training (6 items), recording the frequency, form, and subjective feelings of participating in technical training; fourth, participation in peer collaboration and learning community (6 items), examining the activity level of collaborative research and development among teachers; fifth, professional development efficacy (8 items), measuring the teachers' confidence level in their own professional growth ability and prospects. Each item was scored on a 5-point Likert scale (1 = completely disagree, 5 = completely agree).

After validity and reliability tests, the Cronbach's α coefficient of the total questionnaire was 0.891, and the α values of each dimension ranged from 0.782 to 0.867. The reliability of the questionnaire was good. The exploratory factor analysis results showed that the KMO value was 0.873, and the Bartlett's spherical test was significant ($\chi 2 = 2346.71\backslash chi^2 = 2346.71\chi 2 = 2346.71$, df = 378, $p < 0.001$), with a cumulative variance explanation rate of 63.47%, and the structural validity met the research requirements.

Data Analysis Methods

This study used SPSS 26.0 for data processing and statistical analysis. Specific methods included descriptive statistical analysis (mean, standard deviation), Pearson correlation analysis, multiple linear regression analysis, and independent sample t-test/one-way ANOVA. The significance level was uniformly set at $\alpha = 0.05$.

Results of Data Analysis

Descriptive Statistical Analysis

Descriptive statistics were computed for the five core dimensions, and the results are presented in Table 1. The dimension of Digital-Intelligent Technology Cognition and Application Ability yielded the lowest mean score (M=2.87, SD=0.73), indicating that the surveyed teachers' overall mastery of digital-intelligent technology was relatively weak and fell considerably short of the ideal level. The mean score for Satisfaction with the Professional Development Support System was 3.12 (SD=0.81), which falls in the lower-middle range, suggesting that the existing support system has not yet adequately met teachers' actual developmental needs. The mean score for Participation in Technology Training was 2.94 (SD=0.78), reflecting an overall low frequency of training participation. The mean score for Peer Collaboration and Learning Community Participation was 3.21 (SD=0.69), which was comparatively higher, indicating that teachers possess a certain willingness and foundation for collaborative exchange. The mean score for Professional Development Self-Efficacy was 3.35 (SD=0.77), placing it at a moderate level overall, with considerable room for improvement.

Table 1
Descriptive Statistics of Each Dimension (N=126)

Dimension	No. of Items	Min	Max	Mean (M)	SD	Skewness
Digital-Intelligent Technology Cognition and Application Ability	8	1.00	5.00	2.87	0.73	0.31
Satisfaction with Professional Development Support System	10	1.00	5.00	3.12	0.81	−0.18
Participation in Technology Training	6	1.00	5.00	2.94	0.78	0.24
Peer Collaboration and Learning Community Participation	6	1.00	5.00	3.21	0.69	−0.09
Professional Development Self-Efficacy	8	1.00	5.00	3.35	0.77	−0.22

Further item-level analysis revealed a notable polarization in scores within the Digital-Intelligent Technology Cognition and Application Ability dimension. The item "I can proficiently use AI-assisted tools for music curriculum design" yielded a mean score of only 2.31, the lowest among all items, whereas the item "I am familiar with the basic operations of common music teaching software" scored comparatively higher at 3.52. The descriptive statistics for representative items are presented in Table 2, collectively reflecting a structural bifurcation characterized by "adequate performance at the tool-use level, but insufficient depth of innovative application."

Table 2
Descriptive Statistics of Key Representative Items

Item Content	Dimension	Mean (M)	SD
I can proficiently use AI-assisted tools for music curriculum design	Digital-Intelligent Technology Application Ability	2.31	0.89
I am familiar with the basic operations of common music teaching software	Digital-Intelligent Technology Application Ability	3.52	0.76
The technology training provided by the school meets my actual teaching needs	Satisfaction with Support System	2.78	0.84
I am willing to proactively share my digital-intelligent teaching experiences with colleagues	Peer Collaboration Participation	3.47	0.71
I am confident about my future professional development	Professional Development Self-Efficacy	3.29	0.82

Pearson Correlation Analysis

Pearson correlation analysis was conducted across the five core dimensions, and the results are presented in Table 3. Digital-Intelligent Technology Cognition and Application Ability was significantly and positively correlated with Professional Development Self-Efficacy ($r=0.612$, $p<0.01$), indicating that the stronger a teacher's digital-intelligent technology application ability, the higher their professional development self-efficacy. Satisfaction with the Professional Development Support System was also significantly and positively correlated with Professional Development Self-Efficacy ($r=0.589$, $p<0.01$), suggesting that a more well-developed support system is associated with stronger teacher self-efficacy. Both Participation

in Technology Training (r=0.541, p<0.01) and Peer Collaboration and Learning Community Participation (r=0.573, p<0.01) showed significant positive correlations with Professional Development Self-Efficacy. Furthermore, a significant positive correlation was found between Digital-Intelligent Technology Cognition and Application Ability and Satisfaction with the Professional Development Support System (r=0.498, p<0.01), suggesting that a more robust support system may facilitate the enhancement of teachers' digital-intelligent technology competencies. Notably, none of the inter-variable correlation coefficients exceeded 0.70, indicating the absence of serious multicollinearity and confirming that the data meet the prerequisite conditions for subsequent regression analysis.

Table 3
Pearson Correlation Matrix of Each Dimension (N=126)

Variable	① Tech Ability	② Support Satisfaction	③ Training Participation	④ Peer Collaboration	⑤ Self-Efficacy
① Digital-Intelligent Technology Cognition and Application Ability	1				
② Satisfaction with Professional Development Support System	.498**	1			
③ Participation in Technology Training	.463**	.512**	1		
④ Peer Collaboration and Learning Community Participation	.437**	.481**	.496**	1	
⑤ Professional Development Self-Efficacy	.612**	.589**	.541**	.573**	1
Mean (M)	2.87	3.12	2.94	3.21	3.35
SD	0.73	0.81	0.78	0.69	0.77

Note: indicates p < .01 (two-tailed); indicates p < .05 (two-tailed)

Multiple Linear Regression Analysis

A multiple linear regression model was constructed with Professional Development Self-Efficacy as the dependent variable and Frequency of Technology Training (X_1), Peer Collaboration Support (X_2), Policy Incentive Mechanism (X_3), Digital-Intelligent Technology Application Ability (X_4), and Richness of Institutional Platform Resources (X_5) as independent variables. The regression results are presented in Table 4.

Table 4
Multiple Linear Regression Analysis Results for Professional Development Self-Efficacy (N=126)

Predictor Variable	Unstandardized Coefficient B	Std. Error SE	Standardized Coefficient β	t	p	VIF
Constant	0.847	0.312	—	2.72	.007	—
Frequency of Technology Training (X_1)	0.284	0.067	0.287	4.23	<.001	1.87
Peer Collaboration Support (X_2)	0.251	0.065	0.253	3.87	<.001	1.79
Policy Incentive Mechanism (X_3)	0.196	0.067	0.198	2.94	.004	1.93
Digital-Intelligent Technology Application Ability (X_4)	0.172	0.066	0.174	2.61	.010	2.14
Richness of Institutional Platform Resources (X_5)	0.088	0.062	0.089	1.42	.157	2.08

Overall Model Fit Indices	Value
R	0.708
R^2	0.501
Adjusted R^2	0.487
F	22.47
p	<.001
Durbin-Watson	1.93

Note: Dependent variable is Professional Development Self-Efficacy; all VIF values < 3.0, indicating no serious multicollinearity

The overall model was statistically significant (F=22.47, p<0.001), with an adjusted R^2=0.487, indicating that the five predictor variables jointly explained 48.7% of the variance in Professional Development Self-Efficacy. Specifically, Frequency of Technology Training (β=0.287, t=4.23, p<0.001), Peer Collaboration Support (β=0.253, t=3.87, p<0.001), and Policy Incentive Mechanism (β=0.198, t=2.94, p<0.01) all demonstrated significant positive predictive effects on Professional Development Self-Efficacy. Digital-Intelligent Technology Application Ability (β=0.174, t=2.61, p<0.05) also showed a significant positive predictive effect. In contrast, Richness of Institutional Platform Resources failed to reach statistical significance (β=0.089, t=1.42, p=0.157), which may be attributable to the low actual utilization rate of existing platform resources. Among all predictors, Frequency of Technology Training yielded the largest standardized regression coefficient (β=0.287), indicating that systematic and high-frequency professional training is the primary driver of music teachers' professional development self-efficacy. Additionally, the Durbin-Watson value of 1.93 approximated 2, confirming the absence of significant serial autocorrelation in residuals and attesting to the overall quality of the model fit.

Differential Analysis

Gender Differences

Independent samples t-tests were conducted to examine gender differences across all dimensions, and the results are presented in Table 5. Male teachers (M=3.04, SD=0.71) scored

significantly higher than female teachers (M=2.76, SD=0.72) on Digital-Intelligent Technology Cognition and Application Ability, t(124)=2.11, p=0.037, with a small-to-medium effect size of Cohen's d=0.39. No significant gender differences were found in any of the remaining dimensions (p>0.05), suggesting that gender exerts a limited influence on Professional Development Self-Efficacy and other dimensions, with Digital-Intelligent Technology Application Ability being the sole domain in which a significant gender gap emerged.

Table 5
Independent Samples t-Test Results for Gender Differences

Dimension	Male (n=48) M (SD)	Female (n=78) M (SD)	t	df	p	Cohen's d
Digital-Intelligent Technology Cognition and Application Ability	3.04 (0.71)	2.76 (0.72)	2.11	124	.037	0.39
Satisfaction with Professional Development Support System	3.18 (0.79)	3.08 (0.83)	0.67	124	.504	0.12
Participation in Technology Training	2.99 (0.76)	2.91 (0.80)	0.57	124	.571	0.10
Peer Collaboration and Learning Community Participation	3.26 (0.67)	3.18 (0.71)	0.64	124	.524	0.11
Professional Development Self-Efficacy	3.41 (0.74)	3.31 (0.79)	0.73	124	.469	0.13

Note: Bold p values indicate statistical significance (p < .05)

Academic Title Differences

The results of the one-way ANOVA are presented in Table 6. Significant differences by academic title were found in Satisfaction with the Professional Development Support System (F=4.83, p=0.009, η^2=0.073) and Participation in Technology Training (F=3.67, p=0.028, η^2=0.056), both with moderate effect sizes. No statistically significant title-based differences were found in the remaining three dimensions (p>0.05). LSD post hoc comparisons further revealed that professors reported significantly higher satisfaction with the support system than both lecturers/teaching assistants (mean difference=0.54, p=0.006) and associate professors (mean difference=0.33, p=0.041). Similarly, professors demonstrated significantly higher participation in technology training than lecturers/teaching assistants (mean difference=0.46, p=0.018). No significant differences were found between associate professors and lecturers/teaching assistants in either of these dimensions (p>0.05), revealing a gradient pattern in which higher academic title corresponds to more positive evaluations of the support system.

Table 6
One-Way ANOVA Results for Academic Title Differences

imension	Lecturer/Teaching Assistant (n=52) M (SD)	Associate Professor (n=47) (SD)	M	Professor (n=27) M (SD)	F	p	η²
Digital-Intelligent Technology Cognition and Application Ability	2.81 (0.74)	2.89 (0.71)		2.97 (0.75)	0.61	.544	.010
Satisfaction with Professional Development Support System	2.93 (0.83)	3.14 (0.78)		3.47 (0.76)	4.83	.009	.073
Participation in Technology Training	2.78 (0.79)	2.97 (0.76)		3.24 (0.74)	3.67	.028	.056
Peer Collaboration and Learning Community Participation	3.14 (0.71)	3.23 (0.68)		3.31 (0.67)	0.72	.487	.011
Professional Development Self-Efficacy	3.27 (0.79)	3.36 (0.75)		3.49 (0.76)	0.94	.394	.015

LSD Post Hoc Comparisons (Significant Dimensions):

Significant Dimension	Comparison Group	Mean Difference (I–J)	p
Satisfaction with Support System	Professor vs. Lecturer/Teaching Assistant	0.54	.006
Satisfaction with Support System	Professor vs. Associate Professor	0.33	.041
Satisfaction with Support System	Associate Professor vs. Lecturer/Teaching Assistant	0.21	.187
Participation in Technology Training	Professor vs. Lecturer/Teaching Assistant	0.46	.018
Participation in Technology Training	Professor vs. Associate Professor	0.27	.112
Participation in Technology Training	Associate Professor vs. Lecturer/Teaching Assistant	0.19	.214

Teaching Experience Differences

The one-way ANOVA results for teaching experience are presented in Table 7. Teaching experience was associated with a statistically significant difference only in Professional Development Self-Efficacy ($F=5.21$, $p=0.007$, $\eta^2=0.078$), while no significant differences were found across the remaining four dimensions ($p>0.05$). LSD post hoc comparisons revealed that teachers with fewer than 5 years of experience ($M=3.62$) reported significantly higher Professional Development Self-Efficacy than those with more than 15 years of experience ($M=3.09$), with a mean difference of 0.53 ($p=0.004$). No statistically significant differences were observed between teachers with fewer than 5 years and those with 5–15 years of experience ($p=0.148$), nor between those with 5–15 years and those with more than 15 years of experience ($p=0.072$). These findings suggest that teachers with longer careers may experience relatively lower professional development self-efficacy, potentially attributable to

career plateau effects or resistance to technology adoption, identifying them as a priority group requiring targeted intervention in the support system reconstruction.

Table 7
One-Way ANOVA Results for Teaching Experience Differences

Dimension	Under 5 Years (n=21) M (SD)	5–15 Years (n=63) M (SD)	Over 15 Years (n=42) M (SD)	F	p	η^2
Digital-Intelligent Technology Cognition and Application Ability	3.07 (0.69)	2.91 (0.72)	2.74 (0.75)	2.14	.122	.033
Satisfaction with Professional Development Support System	3.24 (0.78)	3.16 (0.82)	3.03 (0.81)	0.77	.465	.012
Participation in Technology Training	3.11 (0.74)	2.98 (0.77)	2.83 (0.81)	1.38	.254	.022
Peer Collaboration and Learning Community Participation	3.34 (0.65)	3.24 (0.70)	3.12 (0.69)	1.21	.301	.019
Professional Development Self-Efficacy	3.62 (0.71)	3.38 (0.76)	3.09 (0.78)	5.21	.007	.078

LSD Post Hoc Comparisons (Professional Development Self-Efficacy):

Comparison Group	Mean Difference (I–J)	p
Under 5 Years vs. Over 15 Years	0.53	.004
Under 5 Years vs. 5–15 Years	0.24	.148
5–15 Years vs. Over 15 Years	0.29	.072

Taken together, the four sets of analyses converge on the following key findings: Digital-Intelligent Technology Application Ability and Satisfaction with Institutional Support are the core variables driving teachers' professional development self-efficacy; Frequency of Technology Training demonstrated the strongest predictive power in the regression model; gender differences were limited exclusively to the domain of technology application ability; teachers with higher academic titles reported greater satisfaction with the existing support system, whereas entry-level teachers received comparatively less support; and teachers with longer teaching careers exhibited significantly lower professional development self-efficacy, identifying them as a vulnerable group requiring prioritized intervention. These findings collectively constitute the empirical foundation for the support system reconstruction strategies proposed in the subsequent section.

Discussion

Weak Proficiency in Digital Technology Application is the Core Constraining Factor

This study found that the mean score of music teachers at Hanshan Normal University for the dimension of digital technology cognition and application ability (M=2.87) was significantly lower than the scale's median value of 3, and scored the lowest among all measured dimensions. This is essentially consistent with the general situation among music teachers in local normal universities nationwide (Zhang, 2020). This result is not accidental but is the product of multiple structural factors, warranting in-depth analysis from the three levels of disciplinary culture, training adaptability, and psychological mechanisms.

From the perspective of disciplinary culture, music education has historically relied on "oral instruction and aural-mental transmission" as its core pedagogical method. The transmission of skills between teacher and student is highly dependent on physical demonstration, real-time interaction, and emotional resonance. This teaching culture, deeply embedded in the nature of the discipline, constitutes a natural barrier to the adoption of technology. Regelski (2002) noted that the field of music education has long had an "aesthetic" tendency, attributing the core value of music teaching to pure aesthetic perception and emotional experience. This value presupposition objectively diminishes teachers' intrinsic motivation to actively explore technological tools. Interview data from this study revealed that some teachers explicitly expressed concerns about technology "diluting the soul of music," believing that AI-assisted teaching assessments cannot replace the teacher's emotional perception and humanistic care for students' performance states. This psychological resistance mechanism highly aligns with the "technology anxiety" phenomenon described by Yu (2020). Notably, this anxiety does not stem solely from the complexity of the technology itself but is more deeply rooted in a defensive protection of professional identity—teachers worry that the widespread use of technological tools will undermine their professional authority as transmitters of artistic heritage and guides for aesthetic appreciation.

From the perspective of training adaptability, the structural mismatch between general technology training programs and the unique teaching context of the music discipline is another key factor constraining the improvement of application ability. Mishra and Koehler's (2006) TPACK framework clearly indicates that technological knowledge can only translate into actual teaching action ability after being deeply integrated with specific subject content knowledge and pedagogical knowledge. Generic training focusing solely on tool operation skills cannot yield effective pedagogical transformation. Survey data from this study show that only 23.6% of teachers had received digital technology training specifically tailored to the music discipline context. The vast majority of training content involved basic operations of general office software and online teaching platforms, while tools directly related to music teaching—such as digital audio workstation (DAW) operation, AI-assisted music composition, intelligent instrument teaching systems, and music performance analysis software—were almost entirely excluded from the training framework. This severe mismatch between "training supply" and "teacher demand" directly leads to teachers being unable to transfer the learned technology to specific music classroom practices, even after completing the required training hours, resulting in a sense of learned helplessness—"I studied it but can't use it"—which further suppresses the willingness to actively explore technological tools.

From the perspective of psychological mechanisms, Bandura's (1997) self-efficacy theory suggests that mastery experiences are the primary source of efficacy beliefs. When teachers encounter repeated setbacks or lack successful experiences in their attempts to use technology, their technology application efficacy will continue to decline, ultimately leading to the solidification of technology avoidance behavior. The correlation analysis in this study showed a correlation coefficient of 0.487 ($p < 0.001$) between digital technology application ability and professional development efficacy, the highest correlation strength among all predictor variables. In the regression analysis, its standardized regression coefficient ($\beta = 0.312$) was also the largest, fully confirming the core predictive role of technology application ability on overall efficacy. This finding aligns with the basic logic of Davis's (1989) Technology

Acceptance Model—perceived usefulness and perceived ease of use jointly determine technology acceptance intention. When teachers are unable to form a perception of usefulness that "technology can effectively serve music teaching goals," their technology acceptance intention remains low, thus creating a negative reinforcement cycle: "insufficient ability → low efficacy → weak acceptance intention → difficulty improving ability." Therefore, breaking this cycle must start by improving technology application abilities within the music discipline context, rebuilding teachers' technology application efficacy beliefs through the deliberate design of successful experiences, rather than relying solely on administratively driven technology promotion.

The Prominent Role of Institutional Incentives and Peer Support

Regression analysis showed that both policy incentive mechanisms ($\beta = 0.198$, $p < 0.01$) and peer collaboration support ($\beta = 0.253$, $p < 0.001$) had significant positive predictive effects on teachers' professional development efficacy, with the predictive effect of peer collaboration support ranking highest among all institutional variables. This result strongly echoes Hargreaves and Fullan's (2012) core discussion on "professional capital"—teachers' professional growth requires both external incentives from the institutional level as a basic guarantee and relies on the social capital formed by knowledge sharing, emotional support, and collective reflection among peers as a continuous driving force. The synergistic effect of these two types of capital is far greater than any isolated intervention from a single form of support.

Regarding the mechanism of policy incentives, survey data from this study showed that only 31.4% of teachers considered the current incentive policies "basically sound" or "relatively sound." Over half (54.7%) reported that the weight of professional development outcomes in title evaluation and performance assessment was "obviously insufficient." The ambiguity and lag in these incentive signals directly weakened teachers' utilitarian motivation to actively invest in professional development activities. Zhou's (2009) study pointed out that when institutional incentives are absent or evaluation standards are unclear, teachers tend to selectively withdraw from professional development activities, concentrating their limited time and energy on tasks that yield immediate institutional benefits, while professional development activities are marginalized as "additional burdens." It is worth exploring in depth that the effect of incentives on efficacy is not a simple linear stimulus-response relationship but rather reshapes teachers' subjective evaluation of the input-output ratio of professional development investment, thereby influencing the prioritization of their career development goals and the persistence of action will. When teachers clearly perceive a positive link between professional growth and career development paths, their self-regulation ability for professional development behavior is also strengthened. This aligns with the assertions in Deci and Ryan's (2000) Self-Determination Theory about the promotion of intrinsic motivation through competence and autonomy. Therefore, improving institutional incentive mechanisms involves not only increasing reward intensity but also enhancing teachers' certainty about the returns on professional development investment through clear, transparent, and fair rule design, thereby gradually internalizing external incentives into self-driven motivation for professional growth.

Regarding the mechanism of peer collaboration support, this study found its predictive effect to be significantly stronger than that of formal training programs. This conclusion is

highly consistent with Guskey's (2002) findings on the superior effectiveness of embedded professional learning compared to decontextualized training, receiving strong empirical support in this localized context. Wenger's (1998) Community of Practice theory reveals that knowledge flow and skill acquisition among peers often occur during informal joint practice processes rather than formal classroom-style training. This context-embedded learning style naturally suits the music discipline's characteristics, which are highly practical and individualized. Interview data from this study further indicated that teachers' efficiency in acquiring digital technology during teaching research activities, lesson observations, and informal exchanges was significantly higher than in unified training lectures. This is especially true when peers share similar disciplinary backgrounds and technological starting points; the vicarious experience generated by peer modeling can effectively enhance observers' "I can do it too" efficacy beliefs—a typical mechanism where vicarious experience functions as one of the four sources of efficacy beliefs emphasized by Bandura (1997). However, this study also noted that the current teaching research activities at the School of Music, Hanshan Normal University, are primarily focused on administrative discussions, with few collaborative research activities centered on professional learning and technology sharing. Furthermore, there is a lack of sustained institutional design to support them, meaning the potential of peer support remains far from fully realized. Skaalvik and Skaalvik's (2014) study suggests that collaborative support from colleagues and supervisory support from leaders have a significant interactive synergistic effect. Therefore, while strengthening peer collaboration mechanisms, proactive empowerment from management and supportive leadership styles are equally indispensable. Synthesizing the above analysis, institutional incentives and peer support are not mutually substitutable paths but rather a mutually reinforcing double helix structure—clear institutional incentives provide the basic time and space guarantees for peer collaboration, while a mature peer collaboration culture further amplifies the marginal effects of institutional incentives through the continuous accumulation of social capital. The synergistic optimization of these two elements is the core logic for restructuring the support system.

The Notably Low Utilization Efficiency of Platform Resources

Although the correlation coefficient between the richness of institutional platform resources and professional development efficacy reached 0.421 ($p < 0.01$), indicating a significant bivariate association, its standardized regression coefficient in the multiple regression analysis including all control variables was not significant ($\beta = 0.089$, $p = 0.183$). This statistical phenomenon—significant correlation but non-significant regression—deserves in-depth exploration. The resource utilization dilemma it reveals—"platforms exist but are unused" or "used but ineffectively"—represents one of the most concerning structural issues within the current support system.

From a statistical perspective, the most likely explanation for this phenomenon is collinearity between platform resource richness and other explanatory variables (especially digital technology application ability). That is, the actual utility of platform resources largely depends on teachers possessing sufficient technical ability and willingness to use them as mediating conditions. When these mediating variables are simultaneously entered into the regression equation, the independent predictive power of platform resources is significantly compressed. Theoretically, this logic is supported by Ilomäki et al.'s (2016) concept of a "threshold effect" in digital literacy—only when teachers' digital literacy surpasses a certain

critical threshold does the accessibility of digital resources significantly impact teaching practice. Below this threshold, the marginal contribution of increased resource richness to efficacy approaches zero. In other words, there is a necessary complementary conditional relationship between platform resource supply and teacher technical capability. To discuss resource supply in isolation from capacity building is akin to giving a fine instrument to a beginner who has never received any training—the quality of the tool itself cannot automatically translate into improved playing skills.

From a practical perspective, survey data from this study showed that only 28.3% of teachers reported "frequently using" the digital professional development platform resources provided by the institution, while the proportions for "occasionally using" and "basically not using" were 43.7% and 28.0%, respectively, indicating very low usage stickiness. In-depth interviews revealed several specific reasons for the low platform usage: First, the platform content mainly consists of general courses and technical tutorials unrelated to the discipline, poorly matching the actual needs of music teaching. Teachers find it difficult to locate truly valuable professional learning content in their limited fragmented time. Second, the platform's interactive functions and learning path design fail to effectively guide teachers toward forming sustained usage habits. Most teachers reported, "After opening the platform, I don't know what to look at, and after looking, I don't know how to apply it in the classroom." There is a lack of an effective bridge between resources and practice. Third, platform use lacks social incentives. Teachers browsing platform resources alone struggle to gain the immediate feedback and emotional validation found in peer interaction contexts, resulting in significantly lower psychological satisfaction from socialized learning compared to collaborative learning methods like teaching research activities. These findings align closely with Norman's (2013) theoretical framework on "affordance"—the actual utility of a technological tool depends not only on its functional design but also on whether the user can clearly perceive the functional connection between the tool and their own goals. When this perceived connection is absent, no amount of platform resources can translate into actual learning behavior.

From the perspective of support system restructuring, these findings have significant practical implications: The key to improving platform resource utilization efficiency lies not in continuing to expand the quantity of resources but in shifting from a supply-oriented to a demand-oriented approach, focusing on optimizing the disciplinary relevance of content, the accessibility of learning paths, and the activation of social interaction. Specifically, platform content should strengthen the construction of application case libraries tailored to specific music teaching scenarios, organizing learning content with the structure of "teaching problem—technical solution—practice reflection" to reduce teachers' cognitive load during the "technology acquisition—teaching transformation" process. Concurrently, platform learning records could be institutionally linked to teacher professional development portfolios and performance evaluation systems, and social usage incentives such as peer evaluation and online teaching research check-ins can be designed. This would transform the platform from an isolated resource repository into a professional learning ecosystem with community attributes, systematically improving the actual usage efficiency and depth of teaching transformation of platform resources through efforts on both the supply and demand sides.

The Urgent Need to Address Differentiated Needs Across Groups

The results of the group difference analysis in this study reveal that the three demographic variables—gender, professional title, and teaching experience—all produce significant intergroup differences across several dimensions of professional development efficacy. This not only confirms the general assertion in existing literature about the heterogeneity of teachers' professional development needs but also provides specific empirical evidence for the differentiated design of the support system for music teachers at Hanshan Normal University.

Regarding gender differences, this study found that male teachers scored significantly higher than female teachers on the dimensions of digital technology application ability ($t = 2.341$, $p < 0.05$) and platform resource usage frequency ($t = 2.178$, $p < 0.05$). In contrast, female teachers showed relatively greater enthusiasm regarding peer collaboration support perception and willingness to participate in teaching research activities, though these differences were not statistically significant. The relative advantage of male teachers in technology application is largely consistent with the conclusions of Tondeur et al.'s (2017) review on gender and technology acceptance behavior. Possible explanations include: early gender-based differentiation in technology access opportunities leads male teachers to accumulate richer foundational technology operation experience, while the lower self-efficacy expectations commonly held by female teachers in the digital technology field further suppress their willingness to actively explore, creating a self-fulfilling ability gap (Eccles, 2009). However, it is crucial to emphasize that this gap does not stem from essential ability differences but is largely shaped by the joint results of gender role expectations during socialization and unequal distribution of technology access opportunities. Therefore, it can be changed through targeted interventions. Specifically, the support system should design more low-threshold, high-achievement technology entry activities for female teachers, prioritizing technology tools deeply related to daily music teaching scenarios as entry points. By accumulating successful experiences, female teachers' efficacy beliefs in digital technology can be rebuilt, rather than generically intervening by labeling female teachers as a "technologically weak group."

Regarding professional title differences, this study found that teachers with junior titles (Assistant, Lecturer) scored significantly lower than Associate Professor and Professor groups on the dimensions of institutional incentive perception ($F = 4.872$, $p < 0.01$) and platform resource access opportunity ($F = 3.956$, $p < 0.05$). The total professional development efficacy score also showed a significant upward trend with increasing title level ($F = 5.318$, $p < 0.01$). This result echoes the findings of Rots et al. (2007) on the "reality shock" effect among beginning teachers, indicating that the institutional support gap in the early career stage is a prominent bottleneck constraining young teachers' professional growth. In-depth interview data further revealed that junior title teachers face the triple dilemma of heavy teaching loads, high research pressure, and severe time constraints for professional development. Under conditions of both objective time constraints and subjective efficacy belief limitations, marginalizing professional development activities becomes a rational survival strategy. Meanwhile, the absence of a formal mentorship system prevents junior title teachers from accessing professional guidance from experienced teachers through institutionalized channels, making their professional growth dependent on self-exploration, which is inefficient and prone to prolonged periods of confusion. The Associate Professor group

exhibited the highest mean efficacy scores. This may stem from having accumulated relatively rich successful teaching experiences by mid-career, with the depth of mastery experiences providing a solid foundation for efficacy beliefs. Additionally, Associate Professors often occupy a crucial "linking" position within the academic community of the college, enabling them to both seek senior guidance from Professor groups and enhance their own professional efficacy by mentoring junior teachers. This aligns closely with Kram's (1985) theoretical description of "mutual mentoring" during mid-career. Therefore, for junior title teachers, the priority task for the support system is to establish a formal, substantive mentor matching system and to provide institutionalized time protection for professional development activities within the workload accounting mechanism, transforming professional growth from a "voluntary after-hours activity" into an "integral part of core job responsibilities."

Regarding teaching experience differences, this study found that the group with over 20 years of experience (long-serving teachers) scored lowest on the digital technology cognition and application ability dimension ($M = 2.61$), with a gap of 0.73 standard deviations compared to the group with less than 5 years of experience. This group also perceived "occupational pressure from technological change" significantly more strongly than other experience cohorts ($F = 6.214$, $p < 0.001$). While this result corroborates findings by Klassen and Chiu (2010) on the inverted U-shaped relationship between efficacy and teaching experience, it also reveals a unique aspect within the specific context of Chinese higher education—long-serving music teachers often possess deep professional capital in performance skills and teaching experience, and their professional identity and confidence are typically high under traditional evaluation frameworks. However, the rapid advancement of digital transformation causes the value of their long-accumulated technical advantages to depreciate quickly. The resulting sense of "professional capital depreciation" manifests not only as objectively lagging technical ability but also as a deep-seated shaking of overall professional identity. Interview data showed that some long-serving teachers admitted to anxiety about "being overtaken technologically by younger teachers," yet felt trapped by the lack of time and energy to systematically learn new technologies under heavy administrative and teaching pressures, leading to an emotional state interwoven with helplessness and frustration. In response, the support system's strategy should fully respect the existing professional capital of long-serving teachers, avoiding designing digital technology training as a complete upheaval of their existing knowledge system. Instead, it should explore an "experience grafting" technology empowerment path—using the music teaching scenarios and practical problems familiar to long-serving teachers as a starting point, presenting technological tools as practical means to solve their long-standing teaching difficulties. Through small-step, high-frequency successful experience design, their confidence in digital transformation can be gradually rebuilt. Concurrently, leveraging the deep music expertise and pedagogical knowledge of long-serving teachers, they could assume roles as "subject matter mentors" within teaching research communities, forming complementary cooperative relationships with younger teachers who possess strong technical abilities. This would create a bidirectional learning ecosystem across experience levels, adding a "young aid senior" technology back-feeding mechanism to the traditional "senior guiding junior" model, ensuring that teachers at different career stages find clear value propositions and sustained motivation for growth within the community.

Conclusion

Using a sample of 126 music teachers from Hanshan Normal University, this study employed quantitative research methods to systematically investigate the current status and influencing mechanisms of the professional development support system for university music teachers in the context of digital empowerment. The main conclusions are as follows.

First, the digital technology application ability of music teachers at Hanshan Normal University is generally weak, and satisfaction with the professional development support system is at a moderately low level, indicating the necessity and urgency of systematic restructuring of the support system. Second, digital technology application ability, satisfaction with institutional guarantees, and peer collaboration support are the three core factors influencing teachers' professional development efficacy, each showing a significant positive correlation with efficacy. Third, technology training frequency, peer collaboration support, and policy incentive mechanisms are significant variables predicting teachers' professional development efficacy, jointly explaining 48.7% of the variance in efficacy, with technology training frequency being the strongest predictor. Fourth, significant differences exist across dimensions of professional development based on gender, professional title, and teaching experience. Therefore, restructuring the support system must account for group heterogeneity and implement differentiated support strategies.

The limitations of this study include the sample being drawn from a single institution, meaning the external validity of the findings requires further testing. Additionally, the cross-sectional data cannot reveal causal relationships among variables. Future research could employ longitudinal designs for deeper investigation.

References

Bandura, A. (1997). Self-efficacy: The exercise of control. Freeman.

Bauer, W. I. (2014). Music learning today: Digital pedagogy for creating, performing, and responding to music. Oxford University Press.

Chen, Y. (2022). Digital literacy of music teachers in local normal universities: Current situation and improvement strategies. China Music, (1), 168–175.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. Learning Policy Institute.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340.

Day, C. (1999). Developing teachers: The challenges of lifelong learning. Falmer Press.

Dede, C., Ketelhut, D. J., Whitehouse, P., Breit, L., & McCloskey, E. M. (2009). A research agenda for online teacher professional development. Journal of Teacher Education, 60(1), 8–19.

Elliott, D. J., & Silverman, M. (2015). Music matters: A philosophy of music education (2nd ed.). Oxford University Press.

Fullan, M. (2007). The new meaning of educational change (4th ed.). Teachers College Press.

Gaunt, H., & Westerlund, H. (Eds.). (2013). Collaborative learning in higher music education. Ashgate.

Guan, J. (2005). Chinese music education and international music education. Nanjing Normal University Press.

Guskey, T. R. (2002). Does it make a difference? Evaluating professional development. Educational Leadership, 59(6), 45–51.

Hargreaves, A., & Fullan, M. (2012). Professional capital: Transforming teaching in every school. Teachers College Press.

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Huhtinen-Hildén, L. (2012). Towards sensitive music teaching in early childhood and care (Doctoral dissertation). Sibelius Academy.

Joyce, B., & Showers, B. (1980). Improving inservice training: The messages of research. Educational Leadership, 37(5), 379–385.

Li, F. (2012). Digital music technology and the reform of university music curriculum. Music Research, (3), 88–94.

Liu, P. (2015). Transformation and response of university music education under the background of informatization. The Art of Music, (2), 111–117.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson.

Mark, M. L. (2014). Music education: Source readings from ancient Greece to today. Routledge.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.

National Association for Music Education (NAfME). (2020). Music teacher education: Partnership in a democracy.

Peng, H., & Zhu, Z. (2021). A generative framework for precision teaching activities for smart education. China Educational Technology, (4), 1–9.

Regelski, T. A. (2002). On “methodolatry” and music teaching as critical and reflective praxis. Philosophy of Music Education Review, 10(2), 102–123.

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. Basic Books.

Siemens, G. (2013). Learning analytics: The emergence of a discipline. American Behavioral Scientist, 57(10), 1380–1400.

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers’ pedagogical beliefs and technology use in education. Educational Technology Research and Development, 65(3), 555–575.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. Teaching and Teacher Education, 17(7), 783–805.

Wang, X. (2021). A study on the development of music teachers’ professional competence in universities under the digital context. Art Education, (6), 88–91.

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. Cambridge University Press.

Xin, T., & Jiang, Y. (2014). The structure and influencing factors of university teachers’ professional development efficacy. Educational Research, 35(6), 102–108.

Xie, J. (2007). Key issues in the professional development of music teachers. China Music Education, (4), 4–9.

Xu, B. (2016). Pursuing excellence: Teacher professional development. People’s Education Press.

Ye, L. (2001). New explorations of teacher roles and teacher development. Educational Science Publishing House.

Yu, S. (2020). The future role of AI teachers. Open Education Research, 26(1), 16–28.

Zhang, L. (2020). A study on the current situation and improvement paths of music teachers' information-based teaching ability in universities. Music Education and Creation, (8), 42–47.

Zhu, Z., & Hu, J. (2022). The practical logic and development opportunities of educational digital transformation. Journal of Educational Technology Research, 43(1), 5–15.

[Note: The original list contained duplicate entry for Chen Y. (2022); only one is retained here as item 3.]