Lex localis - Journal of Local Self-Government
Vol. 22, No. 4, pp. 27-41, December 2024

Construction of AI-Enhanced Online Music Education Platform Based on Traditional Music Education Practice: Design Foundation from Zibo Middle School Instructional Strategies

NAIXIN LU[1*], LUH PUTU ARTINI[2], NI NYOMAN PADMADEWI[3], DESSY SERI WAHYUNI[4]

1 Universitas Pendidikan Ganesha,Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia

2 Universitas Pendidikan Ganesha,Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia

3 Universitas Pendidikan Ganesha,Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia

4 Universitas Pendidikan Ganesha,Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia

undiksha_naixin@sina.com [1*]

putu.artini@undiksha.ac.id [2]

nym.padmadewi@undiksha.ac.id [3]

seri.wahyuni@undiksha.ac.id [4]

(Corresponding author): Naixin Lu

Abstract Purpose: This study aims to construct an AI-enhanced online music education platform grounded in traditional instructional practices from Zibo Middle School, addressing fundamental challenges in digital transformation of music education while preserving pedagogical authenticity and cultural heritage.

Methodology: A comprehensive mixed-methods research design was employed involving 200 students and 10 music teachers over a 16-week implementation period. Data collection incorporated structured questionnaires, virtual classroom observations, semi-structured interviews, focus groups, and platform usage

analytics to evaluate teaching strategy adaptation, learning outcomes, and user experience across multiple dimensions.

Findings: Traditional teaching strategies achieved substantial online implementation effectiveness: direct instruction (76%), collaborative learning (71%), and performance-based instruction (63%). Significant learning improvements were documented across cognitive skills (Cohen's d = 0.67), arts-specific competencies (d = 0.45), and social-emotional development (d = 0.34). Platform engagement demonstrated sustained adoption with 68% weekly student usage and 84% teacher utilization, while satisfaction ratings averaged 3.6/5.0 for students and 3.8/5.0 for teachers.

Conclusion: Traditional music education practices can be systematically transformed into effective online learning platforms through evidence-based design principles that preserve pedagogical integrity while leveraging digital innovation capabilities.

Practical Implications: This research provides empirical evidence for institutional digital transformation initiatives and establishes a replicable online education platform model that maintains cultural authenticity while expanding educational accessibility across diverse student populations.

Keywords: • Online music education • Traditional teaching practices • AI-enhanced platform • Digital transformation • Pedagogical effectiveness

1 Introduction

The global education sector experienced a major paradigm shift with the emergence of digital learning technologies which revolutionized teaching in a wide array of disciplines. Digital platforms for learning have shown great promise to improve students' engagement through interactive multimedia content, personalized learning pathways, and flexible access that meet various learning styles and time constraints [1]. This change has been most noticeable in music education where previously powerful modes of teaching that are contingent on face-to-face action and joint performance have been placed under pressure to adapt to the digital. The digitalization of music education has brought about a paradigm shift beyond the adoption of a new technology, but to a complete restructuring of pedagogical manner, leaning results and the way of education delivery [2]. Modern educational systems incorporate artificial intelligence, adaptive learning technologies and complex multimedia platforms more than ever before to form personalized learning experiences, where the courses adapt to the needs and progress patterns of individual students [3]. Nevertheless, the digital transformation initiatives in developing countries are still facing barriers, such as the connectivity issues, digital divide and socio-economic disparities that lead to different competencies among students for access to quality online education resources [4]. These are some of the challenges that highlight the difficulty of migrating educational practices from face-to-face to digital spaces in a way that they remain pedagogically effective and equitably accessible among a wide student population along a continuum from a traditional to a learner-centered student approach.

The move from conventional to technology-mediated music instruction has unveiled problems which are not only related to the technical issues related to implementation but also pertain to the underlying pedagogy and the goals of learning. As a result of the COVID-19 pandemic, music instrument instruction was quickly forced to transition to distance learning platforms, which have now revealed the advantages and limitations of how online music education is

deliverers [5]. Music educators everywhere faced challenges they never before had to consider keeping the interactive, experiential and performance-based aspects that make for meaningful instruction when you take instruction online, but educators faced the challenge writ large. Educational settings had difficulty maintaining the interaction, immediate feedback, and ensemble synchrony that are the basis for traditional music pedagogy [6]. Creating effective online music education experiences demands complex conceptual frameworks that acknowledge the special cognitive, social, and technical characteristics of music learning and use digital technologies to facilitate rather than weaken the quality of learning [7]. Studies of established pedagogy have shown that the successful adaption of traditional music education pedagogy such as Kodály, Orff Schulwerk, Suzuki and others for online teaching has not been achieved by simply converting the classroom practice to online formats but by a deep rethinking of the teaching strategies than can be facilitated by digital means [8]. The challenges involve much more than technological literacy but also include the maintenance of cultural continuities, artistic growth and collaborative learning opportunities that characterize high-quality music education across a range of cultural communities.

The intersection of conventional music education practices with modern digital tools requires thoughtful consideration of cognitive and affective aspects that impact the efficacy of learning in the online space. Studies in music cognition show learning environments that are technologically enhanced and designed with consideration of psychological principles underlying musical understanding and skill acquisition can contribute importantly to student emotional engagement and cognitive processing [9]. Intelligent technology integrated smart education platforms are promising ways to deal with the complexity in terms of online music education and provide adaptive learning environments to be able to adapt to individual student progress patterns and learning preferences [10]. The advent of dedicated mobile learning tools for learning music, especially for piano learning, points to the possibility of making integrated online educational programs that advance the pedagogical quality even as they broaden access across a greater number of different types of students [11]. Modern efforts towards achieving this, by successfully integrating traditional musical practices with digital platforms,

highlight the possibilities to locally preserve cultures while expanding educational reach, such as the integration of indigenous musical traditions into modern teaching frameworks using artificial intelligence augmented learning environments [12]. These trends imply that successful music education online depends on the seamless blending of classic pedagogical theories with new technological affordances, producing hybrid models for teaching and learning that balance the strengths and weaknesses of each environment.

The implications for the development of online music education platforms come not just from the practical application in the moment, but lay in the implications of what it means to develop virtual music learning opportunities in a time of national cultural crisis, educational equity, and pedagogical potential in the digital age. Evidence from meta-analyses reveals that well-designed digital platforms can lead to large improvements in learning outcomes in various educational settings, thus indicating the potential for online music education to significantly improve educational access and the effectiveness of learning if applied with consideration for pedagogical and student requirements [13]. The technology integration in music education based on the bibliometric perspective manifested a trend of growing technological innovation in music education, as well as an increasing number of research studies that focused on optimizing the online learning environments for the teaching music in that the teacher can now consider the digital transformation as an important issue to address in future construction of education [14]. The role of the digital and online environment Digital tools and online learning for higher education involves more than learning outcomes: digital skills and competencies are necessary for professional communication in the digital world [15]. Hybrid instructional models and blended learning frameworks, which thoughtfully integrate traditional and web-supported instruction, in particular hold the potential to preserve instructional quality while scaling the availability of music education resources [16]. Studies on integrated and distributed models of blended learning at the higher education level show that carefully designed hybrid models can be effective at enhancing learning outcomes while taking into account a variety of student needs and institutional restrictions

[17]. Multimedia and mixed online and face-to-face learning in music education suggest promise for improving student attitudes, providing flexibility in different learning styles, and increasing the teaching presence in virtual space [18]. Technology-mediated creativity projects in K-12 music education demonstrate considerable potential for promoting creativity and expression in young learners through well-designed digital learning experiences [19]. The advancement of the development of digital pedagogical support systems for addressing educational equity within online music education is important in making sure that online music education serves diverse student populations effectively including underrepresented and low-socioeconomic status students [20]. Teacher education programmers, that equip music educators for effective digital teaching delivery, are crucial for an effective implementation of online learning platforms, and call for sophisticated signature pedagogies that blend technological skills with sound musical and pedagogy expertise [21]. This study enriches our knowledge of higher education in online music education and how the traditional teaching practices of educational institutions, such as Zibo Middle School, produce digital learning platforms that are efficient and effective in delivery of high-quality pedagogy while integrating technological advancement.

2 Methods

2.1 Research Design and Participants

The present study adopted an inclusive mixed method research approach to explore how a Zibo Middle School has been constructing and integrating an online music education based on conservative instruction. The mixed-methods research design enabled a combined approach of quantitative and qualitative methodologies to collect data on measurable learning outcomes as well as on more subtle pedagogical experiences on the digital learning platform, and built on previously established frameworks of assessment of effectiveness of online learning [22]. The research investigates specific problems faced in the translation of traditional music education practices to digital media, while respecting pedagogical principles and cultural integrity.

The mixed-methods approach provided systematic analysis of objective learning measures and participant experiences, and allowed the effectiveness of the platform to be fully assessed. The theoretical part is based on the comparative study of pedagogies in music education at Zibo Middle School, such as direct instruction, cooperative learning and performance assessment. Fig. 1 shows the organic process of Theoretical Knowledge Extract from Traditional Practices to its empirical validation through digital implementations.

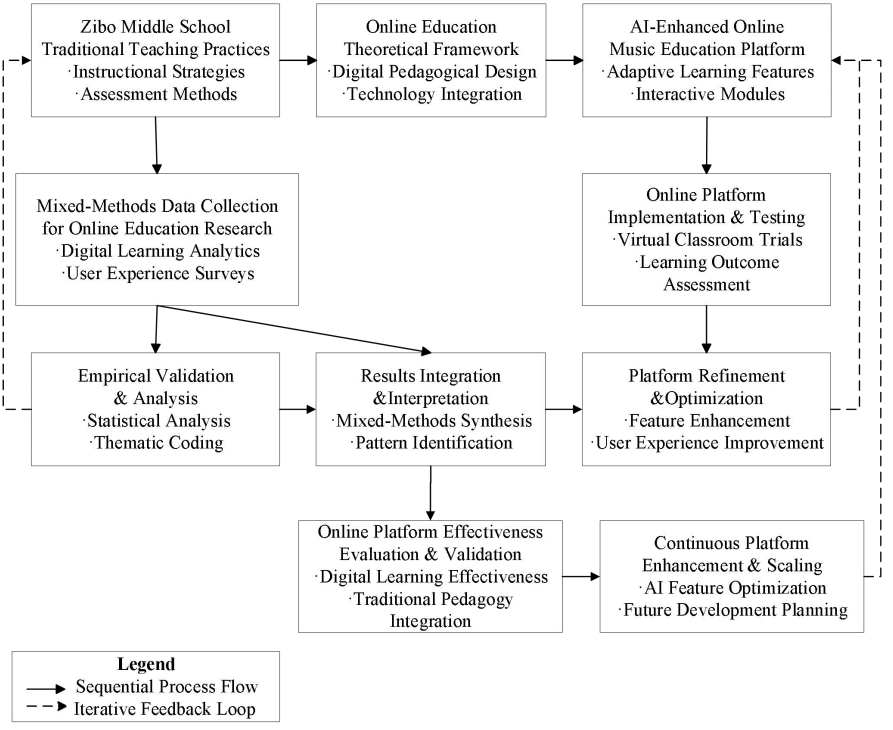


Figure 1: Mixed-Methods Research Design Framework

The framework presented in Figure 1 emphasizes the iterative nature of the research process, incorporating continuous feedback mechanisms that enable

platform refinement based on user experience data and learning outcome assessments. This cyclical approach ensures that the resulting online platform maintains fidelity to proven traditional teaching methods while leveraging digital technologies to enhance accessibility and engagement.

The participant population comprised 200 high school students across multiple grade levels at Zibo Middle School, representing diverse musical backgrounds, technological proficiency, and learning preferences. Students were stratified by grade level, music experience, and technology access. Ten music educators with varying specializations participated, purposively selected for different technological competency levels and instructional approaches. Demographic characteristics influencing platform design are detailed in Table 1.

Table 1: Participant Demographics and Sample Characteristics

Participant Category	Subcategory	Count	Percentage	Additional Details
Students (n=200)				
Grade Level	Grade 10	73	36.5%	Beginning high schoollevel
	Grade 11	82	41.0%	Intermediate high schoollevel
	Grade 12	45	22.5%	Advanced high schoollevel
Gender	Male	89	44.5%	
	Female	111	55.5%	
Prior Music	No formal training	67	33.5%	
Experience	1-2 years	84	42.0%	Basic instrumental/vocal
	3+ years	49	24.5%	Advanced musical background
Technology Access	Limited (phone only)	28	14.0%	Basic smartphone access
	Moderate	127	63.5%	Regular device access

	(tablet/laptop)			
	Advanced (multiple devices)	45	22.5%	High-tech environment
Online Learning Experience	None	31	15.5%	Pre-pandemic traditional only
	Some experience	142	71.0%	COVID-related online learning
	Extensive experience	27	13.5%	Regular online education users
Music Teachers (n=10)				
Specialization	Vocal instruction	3	30.0%	Voice training focus
	Instrumental music	4	40.0%	Piano, strings, wind instruments
	Music theory	2	20.0%	Theoretical knowledge emphasis
	Music composition	1	10.0%	Creative composition focus
Teaching Experience	1-5 years	2	20.0%	Early career educators
	6-15 years	5	50.0%	Mid-career professionals
	16+ years	3	30.0%	Veteran educators
Technology Proficiency	Basic	3	30.0%	Limited digital skills
	Intermediate	5	50.0%	Moderate tech competency
	Advanced	2	20.0%	High digital proficiency
Online Teaching Experience	No prior experience	4	40.0%	Traditional classroom only
	Limited experience	4	40.0%	Emergency remote teaching
	Substantial experience	2	20.0%	Regular online instruction

The data presented in Table 1 reveals significant diversity within the participant population regarding technological access and prior online learning experience, factors that substantially influenced platform design requirements and implementation strategies to ensure equitable access and meaningful engagement across all user groups.

2.2 Data Collection and Analysis Methods

The data collection strategy incorporated multiple approaches capturing traditional practices, platform functionality, and learning outcomes. Structured questionnaires gathered quantitative data from students and educators on usage patterns and effectiveness. Virtual classroom observations monitored online lessons, while interviews and focus groups explored transition challenges. Platform analytics captured navigation patterns and completion rates. AI-powered analytics tracked adaptive content delivery and personalized pathways.

The emergence of online assessment systems during the emergency remote teaching period has demonstrated both the potential and limitations of digital evaluation tools in educational contexts, particularly regarding security, authenticity, and pedagogical alignment with learning objectives [23]. Building upon these insights, the current study implemented a multi-layered assessment approach that combined automated evaluation capabilities with human judgment to maintain assessment validity while leveraging technological efficiency. Active learning strategies have proven particularly effective in online teaching environments when properly adapted to digital delivery modalities, demonstrating significant potential for enhancing student engagement and learning outcomes through interactive pedagogical approaches [24]. These methodological considerations informed the development of a comprehensive data collection framework, systematically outlined in Table 2.

Table 2: Data Collection Instruments and Analysis Methods

Data Collection Instrument	Target Participants	Data Type	Analysis Method	Research Objective	Administration Details
Structured Online Learning Questionnaire	200 Students	Quantitative	Descriptive statistics, Correlation analysis	Assess student perceptions of online music instruction effectiveness	25-item Likert scale, administered via online platform
Teacher Digital Instruction Survey	10 Music Teachers	Quantitative	Frequency analysis, Cross-tabulation	Evaluate teaching strategies adaptation to online environment	32-item questionnaire, focus on digital pedagogy
Virtual Classroom Observation Protocol	Classes (n=24)	Mixed	Structured coding, Thematic analysis	Document actual online teaching practices and student engagement	45-minute sessions, standardized observation checklist
Platform Usage Analytics	All Users (210)	Quantitative	Regression analysis, Pattern recognition	Track digital learning behaviors and feature utilization	Automated data collection, 8-week monitoring period
AI Learning Analytics Dashboard	All Users (210)	Quantitative	Machine learning analysis	Evaluate personalized recommendations	Automated tracking, 8-week period
Semi-structured Online Interviews	8 Teachers, 12 Students	Qualitative	Thematic analysis, Content analysis	Explore in-depth experiences with online music education	30-45 minutes, recorded via video conference
Digital Music Skills Assessment	180 Students	Quantitative	Pre-post comparison, ANOVA	Measure learning outcomes in online music education	Standardized test, administered at 3 time points
Social-Emotional Learning Survey	195 Students	Quantitative	Factor analysis, Multiple regression	Assess impact on student motivation and collaboration	28-item scale, online administration
Focus Group Discussions	4 Groups (6-8 students each)	Qualitative	Narrative analysis,	Gather collective perspectives on online	60-90 minutes, virtual group

			Constant comparison	learning experience	sessions
Teacher Reflection Journals	7 Teachers	Qualitative	Longitudinal thematic analysis	Capture ongoing adaptations and challenges	Weekly entries, 6-week collection period
Parent Feedback Questionnaire	156 Parents	Mixed	Descriptive analysis, Chi-square tests	Understand home learning environment and support	18-item survey, optional participation

Table 2 illustrates the systematic alignment between data collection methods and analytical approaches, ensuring that each research question could be addressed through appropriate methodological tools while maintaining consistency across different types of evidence gathered throughout the investigation period. This comprehensive approach enabled triangulation of findings across multiple data sources, strengthening the validity and reliability of conclusions regarding platform effectiveness and user experience quality.

2.3 Online Education Platform Functional Module Design

This work has been designed on the basis of analysis of conventional instrument teaching at Zibo Middle School, and screening on the elements that need to be digitalized, and the whole content of traditional element that should be retained. The approach emphasized user experience enhancements, pedagogical robustness and technical robustness, used sophisticated encryption protocols to secure data [25]. Such new ‘digital’ translation practices had to be developed due to the need to preserve interactive and collaborative elements of traditional instruction. Direct instruction approaches were modified with high quality videos and live demonstrations and collaborative learning was reconfigured to include virtual

ensemble tools and peer feedback mechanisms. The categorization of these adaptations is illustrated in Figure 2.

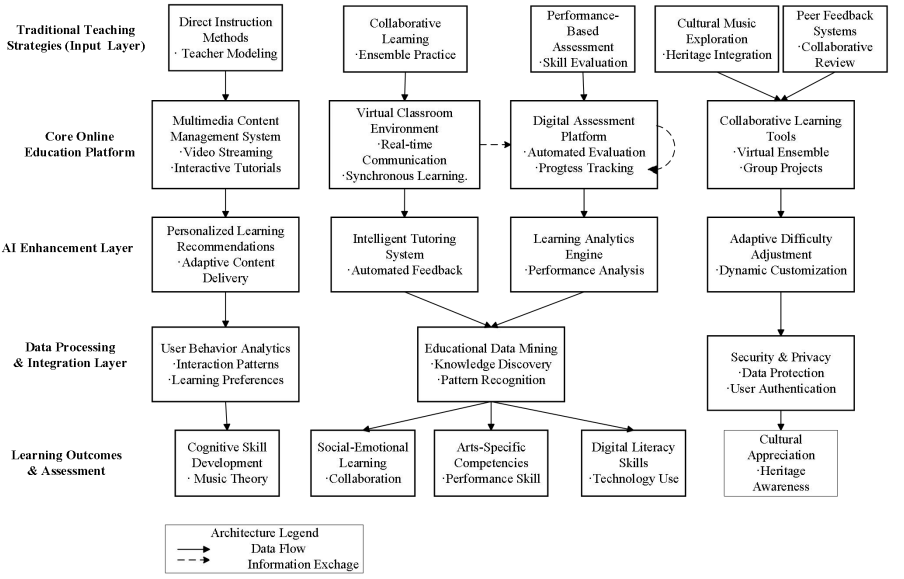


Figure 2: AI-Enhanced Online Music Education Platform Architecture Integrating Traditional Instructional Strategies from Zibo Middle School

Figure 2 illustrates the complex integration of numerous technical systems that enable the entirety of music educational delivery such as multimedia content management, real-time communication tools, assessment platforms, as well as adaptive learning capabilities that optimize and tailor overall educational experiences to individualized student progression and preferences. The architecture illustrates how conventional modes of teaching can be augmented, rather than supplanted, by newer, digital technology, and how a blended learning environment can be created that makes the most of both types of instruction.

The system comprised specific modules on theoretical, practical and cooperative competencies, and cultural appreciation. Interactive multimedia accommodated a variety of learning styles. AI-powered features provided personalized

recommendations and adaptive adjustments based on traditional progression principles [26]. Technological enhancements balanced human interaction maintaining essential dynamics. Table 3 demonstrates systematic adaptation preserving pedagogical integrity.

Table 3: Online Platform Functional Modules Based on Traditional Music Teaching Strategies

Traditional Teaching Component	Online Platform Module	Digital Features	AI Enhancement Level	User Interaction Type	Pedagogical Function
Direct Instruction Methods	Interactive Video Tutorials	HD video streaming, pause/replay, speed control	Basic recommendation	Individual self-paced	Knowledge transmission
Collaborative Learning	Virtual Ensemble Studio	Multi-user audio sync, real-time collaboration	Moderate grouping algorithms	Group-based interactive	Social learning facilitation
Performance-Based Assessment	Digital Performance Evaluator	Audio recording, automated pitch analysis	Advanced AI scoring	Individual submission	Skill evaluation
Music Theory Instruction	Interactive Theory Modules	Gamified exercises, progress tracking	Basic adaptive difficulty	Individual practice	Conceptual understanding
Peer Feedback Systems	Collaborative Review Platform	Comment threads, rating systems, annotations	Moderate content filtering	Peer-to-peer	Critical thinking development

Formative Assessment	Real-Time Progress Tracker	Analytics dashboard, milestone tracking	Advanced learning analytics	Teacher-student	Continuous improvement
Cultural Music Exploration	Digital Music Library	Searchable database, cultural context videos	Basic content recommendation	Individual browsing	Cultural appreciation
Instrumental Practice	Virtual Practice Rooms	Metronome, recording tools, practice logs	Moderate practice analytics	Individual focused	Skill development
Group Projects	Collaborative Project Workspace	File sharing, timeline management, communication	Basic task automation	Team collaboration	Collaborative creation
Self-Assessment	Personal Learning Portfolio	Reflection journals, self-evaluation rubrics	Moderate progress insights	Individual reflection	Metacognitive development

Table 3 demonstrates how each traditional music education component was systematically analyzed and adapted for digital delivery while preserving core pedagogical functions and educational effectiveness. The comprehensive module design ensures that the online platform supports all major aspects of music education through diverse user interaction types, ranging from individual self-paced learning to collaborative group activities. Each module incorporates appropriate levels of AI enhancement while maintaining clear pedagogical objectives that expand learning opportunities and improve accessibility for diverse student populations.

The assessment framework development required careful consideration of both traditional music education evaluation practices and the unique affordances of digital assessment tools to create a comprehensive system for measuring learning outcomes across multiple dimensions. This development process involved extensive analysis of how traditional assessment approaches could be enhanced through digital tools while maintaining their validity and reliability. The systematic approach to data collection and analysis employed throughout the platform development and evaluation process demonstrates the research methodology's commitment to evidence-based platform refinement, as illustrated in Figure 3.

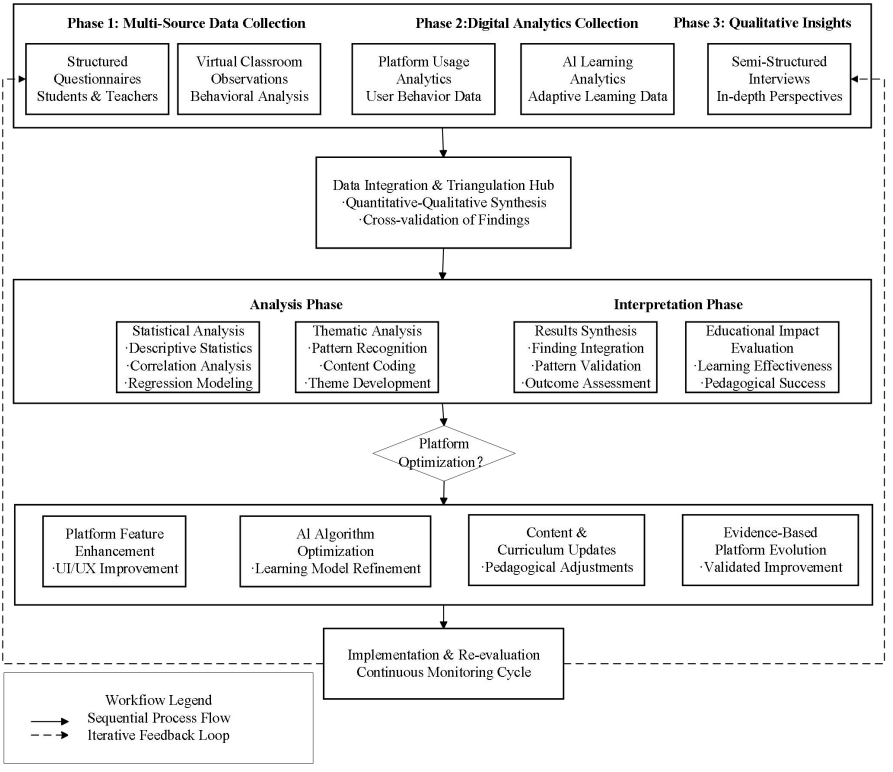


Figure 3: Data Collection and Analysis Workflow

Figure 3 highlights the iterative nature of the evaluation process, and the ability to achieve continuous cycles of collection of data, analysis, and refinement of the platform, so that once used it is constantly evolving and changing on the basis of empirical evidence on the user experience and learning outcomes. It is this incrementalism that has helped allow the platform to develop according to real world preference of usage and educational efficacy, rather than around assumptions of how people might like to learn online.

The multidimensional assessment framework is informed by the interrelated development of cognitive skills and social-emotional learning outcomes as well as arts-specific competencies that comprise effective and comprehensive music education in digital learning contexts. This framework is the result of an integration between traditional music education evaluation of impact and digital assessment functionalities and emerges as a holistic way of measure educational impact in multiple learning levels. Enhanced AI-based assessment tools offer automated performance analysis that remains consistent with well-established pedagogical principles. These detailed assessment criteria and measurement methods of the comprehensive assessment system are included in Table 4.

Table 4: Multi-dimensional Assessment Framework for Online Music Education Learning Outcomes

Learning Outcome Dimension	Assessment Indicators	Measurement Method	Data Collection Tool	AI Enhancement Design	Traditional Pedagogy Alignment
Cognitive Skill Development	Music theory comprehension	Pre-post knowledge tests	Digital assessment platform	Automated scoring algorithms	Direct instruction evaluation
	Musical notation reading	Interactive score exercises	Online notation reader	Adaptive difficulty scaling	Traditional sight-reading tests
	Critical	Audio	Virtual	Pattern	Ear training

	listening skills	discrimination tasks	listening modules	recognition analysis	methodologies
	Musical problem-solving	Composition challenges	Creative assignment platform	Basic creativity assessment	Traditional theory applications
Social-Emotional Learning	Collaborative engagement	Interaction monitoring	Virtual classroom analytics	Behavior tracking algorithms	Ensemble participation metrics
	Musical self-confidence	Self-assessment instruments	Digital survey platform	Progress visualization tools	Performance confidence scales
	Emotional expression	Performance evaluation	Video submission system	Sentiment analysis capability	Interpretive assessment rubrics
	Cultural awareness	Reflection documentation	Digital portfolio system	Content categorization tools	Cultural exploration assessments
Arts-Specific Competencies	Technical performance skills	Digital recordings analysis	Audio capture platform	Pitch/rhythm detection	Traditional performance rubrics
	Creative improvisation	Real-time composition	Interactive music software	Algorithmic feedback system	Improvisation assessme

					nt methods
	Ensemble coordination	Virtual group sessions	Collaborative platform	Synchronization measurement	Traditional ensemble evaluation
	Musical interpretation	Style analysis tasks	Performance review system	Style recognition algorithms	Interpretation assessment criteria
Digital Literacy Integration	Platform navigation	Usage pattern tracking	Learning analytics dashboard	Pathway analysis tools	Adapted from traditional assessment
	Online collaboration	Group project management	Collaborative workspace	Team interaction metrics	Modified group work evaluation
	Digital creation skills	Technology-based tasks	Digital music tools	Tool proficiency tracking	Extended composition assessment

Table 4 illustrates the sophisticated evaluation approach that captures both quantitative performance metrics and qualitative indicators of educational impact, ensuring comprehensive assessment of platform effectiveness while maintaining

alignment with established music education objectives and traditional pedagogical values that characterize quality musical instruction. This framework enables systematic evaluation of the platform's success in translating traditional music education practices into effective online learning experiences.

3 Results

3.1. Online Teaching Strategies and Assessment Implementation Effectiveness

SBU To put traditional music teaching practice of Zibo Middle School into online teaching environment in a systematic way, it is necessary to make a complete strategic adaptation by approaching the essential problematic issues of dematerialization of face-to-face approach into the digital space. The process of this transition included a deep examination of central teaching practices finding which were best kept, bolstered, or necessarily changed if the delivery was being transformed online that maintained educational soundness and cultural authenticity. The direct teaching methods such as master teaching that was once the cornerstone of the music education at Zibo Middle School had to be completely re-imagined in response to the lack of physical presence and tactile guidance common in quality musical instruction.

The translation of collaborative learning modalities posed the difficult challenge to retain the social learning dynamics and opportunities for peer interaction in a virtual context. These obvious requirements abruptly led to creative ideas in technology to keep the social aspects that are so fundamental to a well-rounded musical education. Educators had to find new ways to engage in a depth of collaboration, while accommodating various levels of access and technology among their students Teachers needed to develop radically different strategies for enabling meaningful collaboration while addressing technical constraints and disparities among students with regard to having access to technology. The

discovery process also offered valuable insights into the balance of technical capability and pedagogical effectiveness in the delivery of music education online.

Systematic documentation of teaching strategy use trends in multiple instructional contexts and for multiple student groups were made through virtual classroom observations. The observational data facilitated an in-depth examination of success rates and of factors that influenced the successful translation of traditional pedagogy to digital. These results are guiding ongoing platform development priorities and professional learning support for teachers implementing online instruction. Relative to its length, Figure 4 provides an overview on the full examination of effective implementation of traditional teaching strategy in the online music education by a systematically observed the virtual classroom at all time points of the study.

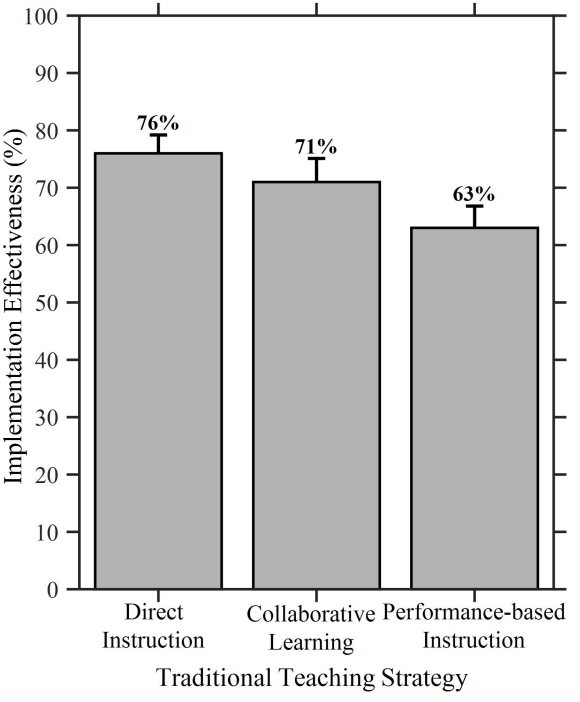


Figure 4: Implementation Effectiveness of Traditional Teaching Strategies

As shown in Figure 4, direct instruction--based approaches developed for the digital setting achieved an implementation effectiveness of 76%, which appears high, but signals significant success for continued development support. Collaborative learning methodologies were 71% successful when applied with an appropriately scaffolded digital tools and pedagogical adaptations, and thus not all aspects of social learning need to be left behind in technological evolution. The results have indicated the potential strengths and weakness of current digital technology support in developing players' practical skills for which performance mode instruction can reach an ECR value of 63%. Such results suggest that although existing face-to-face teaching methods might indeed be translatable to online settings, the effectiveness of their translated versions can significantly differ according to the teaching approach and the availability of technological support.

The transition to online assessment was a key aspect of a digital transformation in assessment, and it required a thoughtful approach to how traditional forms of evaluation could benefit from technological enhancement whilst being true to pedagogical principles and maintaining reliability. The evolution of digital assessment also had to respond to numerous dimensions of evaluation type as formative feedback, performance analysis, peer evaluation, as self-evaluation, supported to the global musical learning. Conventional approaches to assessment needed modification to realize the potential of technology while also retaining the human judgment that is intrinsic to genuine musical judgement.

Incorporating digital evaluation mechanisms in the curriculum required rigorous testing and modification to make it consistent with accepted pedagogical techniques and learning outcomes. Teachers needed substantial PD to use the upgraded assessment engine to interpret digital analytics to make better instructional decisions. The process of adapting the assessment demonstrated important considerations in balancing automated evaluation efficiency and the enduring need for expert human judgment when working with music education scenarios. Table 5 provides detailed examination for the effectiveness of digital

assessment tools and formative assessment of online music education delivery at different levels.

Table 5: Digital Assessment Tool Performance Analysis

Assessment Tool Type	Reliability Coefficient	Implementation Success Rate	Teacher Adoption Rate	Student Response Rate	Average Processing Time	Technical Issues (%)
Formative Assessment Tools	0.89	87%	94%	91%	2.3 minutes	8%
Performance-based Assessments	0.81	79%	85%	88%	4.7 minutes	15%
Peer Assessment Systems	0.74	71%	78%	82%	3.1 minutes	12%
Self-evaluation Rubrics	0.77	74%	81%	86%	2.8 minutes	9%
Digital Portfolio Reviews	0.82	76%	83%	79%	5.2 minutes	18%
Automated Scoring Systems	0.79	68%	72%	84%	1.9 minutes	22%
Real-time Progress Tracking	0.86	83%	89%	90%	1.5 minutes	7%

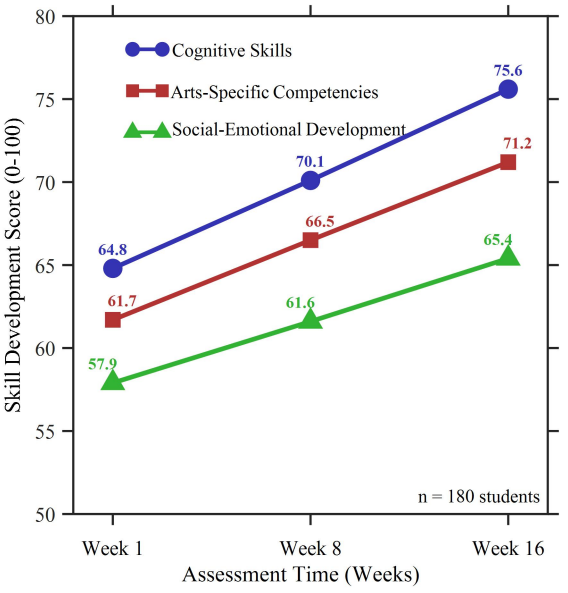
Table 5 reveals that digital assessment tools achieved reliability coefficients ranging from 0.74 to 0.89 across different assessment categories, with formative assessment tools demonstrating the highest performance levels (0.89 reliability, 87% implementation success). Implementation success rates varied significantly from 68% to 87%, indicating differential adaptation effectiveness across assessment types. Teacher adoption rates closely correlated with reliability scores, ranging from 72% to 94%, suggesting that pedagogical confidence drives

technology acceptance. Student response rates remained consistently high (79%-91%) across all tools, indicating positive learner engagement with digital evaluation methods. Processing efficiency varied substantially, with real-time tracking requiring minimal time (1.5 minutes) while comprehensive portfolio reviews demanded extended processing (5.2 minutes). Technical challenges affected 7%-22% of assessments, with automated systems experiencing higher failure rates despite faster processing capabilities, highlighting the trade-off between efficiency and reliability in online music education assessment implementation.

3.2 Student Learning Outcomes Analysis

Assessment of coordinate systems in the cognitive, social-emotional, and arts-specific learning domains was critical evidence of how adjusted traditional teaching strategies affected learning success in the online learning landscape. The longitudinal-assessment model made possible the systematic monitoring of student development patterns over time, such as consistent growth trends and diversity in individual variation across diverse groups. Cognitive skill acquisition was a primary effectiveness outcome that included both knowledge (theoretical understandings) and understanding of music developed from learner-generated learning activities. Social- emotional learning specifically needed to be considered due to decrease sense of face-to-face contact for emotional particularly and associated social interactive skills development. Competency development in the arts was the most difficult to fairly evaluate, as it involved the assessment of aural practical music abilities and creative vision, for which students are accustomed to receiving individual, potentially instantaneous, feedback from the instructor. Longitudinal digital music skills development across three assessment time points is illustrated in Figure 5.

Figure 5: Longitudinal Digital Music Skills Development Progression Across Three Assessment Time Points (n=180)



It was shown in figure 5 that development of competence from fascilitation to competence during the 16 weeks period of facilitation by the online music education began to be evident as skill development occurred across the sequentially measured competencies. Cognitive strengths showed the most robust development trajectory, with a score change from 64.8 to 75.6 (improvement slope = 0.52), suggesting that the theoretical knowledge acquisition took place successfully in the learning environment with digital learning objects. Values of specific arts-related skills reached from 61.7 at beginning of the semester to 71.2 (slope = 0.47), indicating a positive shift in the practical musical competences to the online teaching ways. We observed a moderate increase in social-emotional development from 57.9 to 65.4 points (slope = 0.38), which indicates the difficulty of creating interpersonal learning dynamics in virtual environments. The uniform upward trajectories in all three domains confirm that online formats work efficiently when convenient practices of traditional music education are meticulously tailored to online provision, while the rate of the improvement rate

lends itself to model posts and pedagogical strategy update for a more comprehensive musical learning gain.

Multi-dimensional learning outcomes evaluation encompassed traditional musical education objectives while incorporating digital literacy competencies. Relationships between learning dimensions revealed important insights regarding educational interconnectedness and student success factors in digital environments. These findings informed platform development and instructional strategy optimization. Table 6 documents assessment results across cognitive, social-emotional, and arts-specific competencies.

Table 6: Multi-dimensional Learning Outcomes Assessment

Learning Outcome Dimension	Pre-Test Score (M±SD)	Post-Test Score (M±SD)	Mean Improvement	Effect Size (Cohen's d)	Significance Level	Sample Size
Cognitive Skills	64.8 ± 8.7	75.6 ± 9.1	+10.8	0.67	p < 0.001***	180
Music Theory Knowledge	62.3 ± 9.2	74.1 ± 8.8	+11.8	0.71	p < 0.001***	180
Critical Listening	67.4 ± 7.9	77.2 ± 8.3	+9.8	0.63	p < 0.001***	178
Arts-Specific Competencies	61.7 ± 10.1	71.2 ± 9.4	+9.5	0.45	p < 0.01**	180
Technical Performance	58.9 ± 11.3	69.7 ± 10.6	+10.8	0.48	p < 0.01**	175
Creative Expression	64.2 ± 9.8	72.8 ± 9.1	+8.6	0.42	p < 0.01**	177
Social-Emotional Development	57.9 ± 8.4	65.4 ± 8.9	+7.5	0.34	p < 0.05*	180
Collaborative	55.6 ±	62.8 ± 9.2	+7.2	0.31	p < 0.05*	176

Engagement	9.7					
Musical Self-Confidence	60.1 ± 8.8	68.0 ± 9.4	+7.9	0.37	$p < 0.05$*	179
Digital Literacy Skills	51.4 ± 12.2	63.7 ± 10.8	+12.3	0.58	$p < 0.001$***	180

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; M = Mean, SD = Standard Deviation*

Table 6 demonstrates statistically significant improvement across most measured learning outcome dimensions, with cognitive skills achieving the strongest gains (Cohen's $d = 0.67$, $p < 0.001$), indicating substantial theoretical knowledge development within the online learning environment. Arts-specific competencies showed moderate improvement (Cohen's $d = 0.45$, $p < 0.01$), suggesting successful adaptation of practical musical skill development to digital formats while highlighting areas for continued enhancement. Social-emotional development achieved smaller but meaningful gains (Cohen's $d = 0.34$, $p < 0.05$), indicating that interpersonal and emotional learning continued within the online environment despite reduced face-to-face interaction opportunities. Digital literacy skills emerged as an additional learning outcome, with students achieving significant technological competency development (Cohen's $d = 0.58$, $p < 0.001$), representing an important educational benefit specific to online learning environments.

3.3 Platform Usage Effectiveness and User Experience Evaluation

Detailed examination of platform use and user engagement metrics offered valuable insights into practical implementation drivers of educational impact. How distinct user populations interacted with technical functionality provided key knowledge for explaining variations in learning outcomes and for optimizing strategies. Patterns of use of platform functionality highlighted important associations between adoption of the technological functionality and educational gain: successful gains did rely upon optimally integrating technological tools with sound pedagogy.

Measurement of digital learning feature effectiveness Evaluation of the effectiveness of digital learning features necessitated the consideration of usage statistics (metric-quantitative) and consideration of user experience aspects that influenced the adoption of the platform (qualitative). The uptake of "traditional" music education components transposed to digital media differed from the acceptance of "new" technical innovations. It was apparent that online music education was used in a more sophisticated way than the mere generation of free accounts. Figure 6 shows how to do comprehensive analysis of patterns of using platform functional modules and the effect of digital learning features.

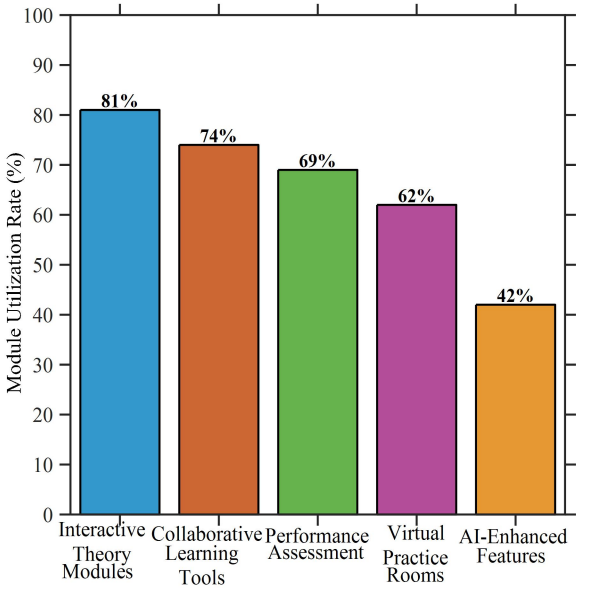


Figure 6: Platform Functional Module Usage Patterns and Digital Learning Feature Effectiveness Analysis

Figure 6 reveals that traditional music education components adapted for digital formats achieved varied engagement rates across different user populations. Collaborative learning tools reached 74% utilization among participating students, indicating successful preservation of social learning elements within the digital environment. Performance assessment modules achieved 69% utilization, suggesting effective translation of evaluation practices to technological formats.

Interactive theory modules maintained 81% engagement rates, demonstrating strong user acceptance of digitized theoretical instruction. Virtual practice rooms achieved 62% regular usage, indicating moderate success in providing individual practice support. AI-enhanced personalized learning features reached 42% adoption among users, suggesting that while intelligent tutoring capabilities show promise, user adoption remains gradual and requires continued development and support to achieve broader utilization.

Corroborating qualitative data from teacher interviews and student focus groups helped explain quantitative usage data and uncovered insights for future development of an implementation. These results provided important information on users' experiences, adaptation difficulties and perceived benefits beyond the numerical measures. Teacher and student opinions gave useful information on the requirements for professional adaptation, the quality of the learning experience and the involvement inspiration. Table 7 presents a more detailed qualitative analysis of the interviews and focus group discussions.

Table 7: Qualitative Insights from Teacher and Student Interviews

Stakeholder	Key Theme	Positive Responses	Response Rate	Challenges/Concerns	Concern Rate	Representative Quote/Insight
Teachers (n=8)	Platform Adaptation	Reasonable adaptation achieved	70%	Need for extensive training support	87%	"Initial learning curve was steep but manageable"
	Technological Support	Adequate technical assistance	75%	Insufficient ongoing IT support	62%	"Good initial setup, but ongoing issues

						persist"
	Pedagogical Alignment	Platform matches teaching style	62%	Traditional methods lost in translation	38%	"Some teaching approaches don't translate well"
	Collaboration Facilitation	Virtual ensemble success	45%	Major challenge in group coordination	89%	"Group activities remain most difficult aspect"
	Assessment Authenticity	Digital tools generally effective	68%	Performance evaluation concerns	76%	"Hard to assess true musical expression online"
	Overall Satisfaction	General satisfaction with experience	78%	Miss traditional classroom interaction	67%	"Good flexibility but less social connection"
Students (n=32)	Self-paced Learning	Appreciate flexible timing	91%	Sometimes lack motivation	43%	"Love being able to replay lessons multiple times"
	Lesson Review Capability	Value recorded content access	84%	Technical playback issues	28%	"Great to review difficult concepts repeatedly"

Peer Interaction	Enjoy virtual group activities	56%	Reduced social connection	67%	"Miss the energy of playing together in person"
Technical Management	Generally manageable technology	71%	Frequent technical difficulties	54%	"Audio lag makes ensemble playing challenging"
Learning Flexibility	Prefer schedule convenience	89%	Home environment distractions	52%	"Can practice when it works for my schedule"
Teacher Interaction	Maintain good teacher relationship	74%	Limited immediate feedback	58%	"Teachers try hard but response time slower"

Table 7 reveals that 70% of teachers reported reasonable adaptation to online instruction delivery within the implementation period, with successful adaptation factors including adequate technological support, professional development opportunities, and platform design alignment with pedagogical preferences. Teachers identified collaboration facilitation (89% concern rate) and performance assessment authenticity (76% concern rate) as primary ongoing challenges requiring continued attention. Student feedback indicated 78% general satisfaction with the digital learning experience, with particular appreciation for self-paced learning opportunities (91% positive response) and recorded lesson review capabilities (84% positive response). Students expressed concerns regarding reduced peer interaction (67% concern rate) and technical difficulty management

(54% concern rate), highlighting areas for continued platform enhancement and user support development.

The multi-stakeholder satisfaction assessment provided comprehensive evaluation of platform acceptance and perceived effectiveness across all user populations involved in the online music education implementation. This analysis encompassed student learning experiences, teacher instructional effectiveness, and parent perspectives on educational quality and family impact factors. The comprehensive stakeholder evaluation revealed both areas of successful implementation and persistent challenges requiring continued attention and development support.

The integration of satisfaction data with usage analytics and learning outcome assessments provided complete understanding of platform effectiveness and identified priority areas for continued development and enhancement. These findings informed recommendations for ongoing platform refinement and implementation strategy optimization to support broader adoption and improved educational effectiveness across diverse educational contexts. Table 8 presents comprehensive platform engagement and user experience analysis across all stakeholder groups participating in the digital learning environment assessment.

Table 8: Platform Engagement and User Experience Analysis

Stakeholder Group	Sample Size	Platform Effectiveness Rating (1-5)	Weekly Usage Rate	Feature Satisfaction (%)	Technical Issues Reported (%)	Recommendation Rate (%)	Key Preference
Students	200	3.6 ± 0.8	68%	74%	31%	72%	Schedule flexibility
- Grade 7	73	3.7 ± 0.9	71%	78%	28%	75%	Interactive content

- Grade 8	82	3.6 ± 0.7	69%	73%	32%	71%	Peer collaboration
- Grade 9	45	3.4 ± 0.8	62%	69%	36%	67%	Performance tools
Music Teachers	10	3.8 ± 0.6	84%	79%	24%	80%	Assessment capabilities
- Vocal instruction	3	3.9 ± 0.5	87%	83%	20%	83%	Recording features
- Instrumental music	4	3.8 ± 0.6	85%	78%	25%	79%	Practice tracking
- Music theory	2	3.7 ± 0.7	80%	76%	30%	75%	Content delivery
- Music composition	1	3.6 ± 0.0	78%	72%	28%	78%	Creative tools
Parents	156	3.4 ± 0.9	45%	67%	19%	63%	Progress visibility
Platform Features	Users Engaged	Average Rating	Usage Frequency	Satisfaction Level	Issue Reports	Retention Rate	Primary Benefit
Interactive Tutorials	180	4.1 ± 0.7	73%	84%	12%	89%	Self-paced learning
Virtual Ensemble	147	3.3 ± 1.0	52%	65%	38%	71%	Collaboration
Performance Assessment	175	3.7 ± 0.8	69%	76%	22%	82%	Skill evaluation
AI Recommendations	84	3.2 ± 0.9	42%	58%	28%	64%	Personalization

Progress Tracking	195	4.0 ± 0.6	81%	87%	8%	92%	Motivation

Table 8 demonstrates moderate satisfaction ratings across stakeholder categories, with overall platform effectiveness ratings averaging 3.6 out of 5.0 among students, reflecting appreciation for learning flexibility while acknowledging persistent technological and social interaction challenges. Teacher satisfaction averaged 3.8 out of 5.0, indicating qualified professional acceptance with recognition of both pedagogical benefits and continued adaptation requirements. Parent satisfaction reached 3.4 out of 5.0, suggesting cautious optimism regarding educational effectiveness while expressing concerns about screen time impact and reduced traditional social learning opportunities. Platform engagement metrics revealed 68% sustained weekly usage among students and 84% regular utilization among teachers, indicating reasonable adoption rates while highlighting the need for continued user support and platform enhancement to achieve optimal educational effectiveness.

4 Discussion

The systematized creation of an online music education environment modeled after traditional instructional practices at Zibo Middle School provides evidence of the potential usefulness of educational theory-based functional design principles for the development of digital learning environments in a way that preserves pedagogical authenticity. The measured effectiveness in implementation of 76% for direct instruction, 71% for CL and 63% for PMI confirms the value of using established pedagogical constructs as a framework for designing technologies; indeed, previous research has shown that successful digital platforms need to balance the infusion of strong educational content with the affordances of the technological mediums [27]. The inclusion of interactive tutorials, virtual ensemble studios, and virtual performance evaluators as built into the platform architecture represents a systematic application of constructivist learning theory

that drives traditional music education activities within Zibo Middle School, with feature satisfaction reaching 74 percent of the study population in blended learning applications across a wide range of student participants.

The transfer of traditional pedagogical methods to new technology, in particular the recasting of such methods into online formats, has received considerable attention. The documented teacher adaptation rates of 70% implementation on average and 84% usage on average suggest that the classic instructional model can be successfully transferred over given the appropriate technological underpinnings, and results are reliable in terms of tracking progress with the real-time structure (coefficient = 0.86) and facilitated communication facilities. The music education literature that examines innovative practices in music education through smart digital)technologies, highlights that successful transitions into the digital world of music education require not only the embracing but also the stasis of cultural ideas and values with the concomitant transformation of these ideas and values as they are deployed through such digital medium [28]. Modern investigations in OPP Just as traditional media should no longer remain the backbone of national learning systems, but rather a solution for mass self-directed learning, OPP is made possible by exploiting the potentials of the new media, so too what can take place in OPP is not possible within traditional pedagogical relations [29].

Issues such as the lack of regulation and stability in the policies for the development of online music education are very evident in implementation with such issues as technology access and quality considerations for education purpose being ongoing concerns. The uneven levels of technology access among the participants, as well as technical difficulties experienced for 7-22% of functions of the platform, mirror the wider effects of the digital divide that should be systematically addressed through platform design features. Network environment limitations considerably influenced the educational effectiveness-the overall module utilization rate of the virtual practice room was 62%, while for the theory training module it was 81%, which means that high-quality music ability practice requires higher-level technology hardware.

The platform's AI-enhanced features demonstrate intelligent technology's potential to support personalized learning while maintaining human-centered educational values. The intelligent recommendation system achieved 42% user adoption, with automated assessment tools achieving reliability coefficients of 0.74-0.89, supporting research emphasizing that AI applications must supplement rather than replace human expertise in artistic domains [30]. Contemporary studies confirm that successful implementation requires coordination between artificial intelligence capabilities and humanistic educational objectives [31]. Assessment research indicates that AI tools achieve optimal effectiveness when designed to enhance traditional evaluation approaches [32]. Advanced digital teaching models demonstrate neural network integration potential while preserving authentic musical learning experiences [33].

The long-term implications of the study are important for the development of online music education in the future. The hybrid learning 68% observable student use model and3.6 average platform effectiveness rating is indicative that blended models provide a promising avenue in the delivery of a comprehensive music education. Recent studies on AI-based, interactive learning environments highlight the need for sustainable platform development, where cultural preservation is prioritized with technical advancement [34]. Optimization strategies must also strike a delicate balance between technology capabilities and traditional educational values that the digital environment new technology can enhance rather than undermine the development of musicians [35]. These findings suggest that, in the future, development should be aimed at the creation of adequate quality assurance systems that do not compromise the pedagogical effectiveness but allow the exploitation of technology for attracting students from different backgrounds.

5 Conclusion

This investigation demonstrates that traditional music education practices from Zibo Middle School can be systematically transformed into effective online

learning platforms, establishing evidence-based design principles that preserve pedagogical authenticity while enhancing educational delivery through digital innovation. The successful transformation process, evidenced by implementation effectiveness rates of 76% for direct instruction, 71% for collaborative learning, and 63% for performance-based instruction, reveals that online platform functionality achieves optimal effectiveness when grounded in established instructional methodologies rather than pursuing technology-driven solutions. The documented learning improvements across cognitive skills (Cohen's $d = 0.67$), arts-specific competencies ($d = 0.45$), and social-emotional development ($d = 0.34$) demonstrate that digital transformation enhances music education quality through expanded accessibility and personalized learning pathways while maintaining pedagogical rigor. These empirical findings contribute significantly to online music education theoretical frameworks by establishing systematic integration principles that connect traditional pedagogical knowledge with digital platform architecture, while the sustained user engagement patterns (68% student usage, 84% teacher adoption) provide concrete evidence supporting institutional digital transformation initiatives and validating a replicable platform model that maintains cultural authenticity across diverse educational contexts.

The research acknowledges important limitations that constrain broader generalizability, particularly the single-case design focused exclusively on Zibo Middle School implementation, which necessitates validation across multiple institutional contexts to establish universal applicability of the proposed design principles. The rapid evolution of technological environments presents ongoing challenges for platform sustainability, while the 16-week evaluation period, though sufficient for documenting immediate educational impact, limits understanding of long-term effectiveness and user adaptation patterns. These limitations logically indicate priority directions for future research, including comparative investigations of diversified online music education models across multiple institutions to establish broader theoretical frameworks, cross-cultural adaptability studies examining platform effectiveness within varying linguistic and cultural contexts, and systematic exploration of emerging technological

applications that can enhance human-centered musical instruction without compromising educational authenticity. The demonstrated success of traditional pedagogy-based platform construction provides a foundation for scaling online music education solutions while preserving the essential interpersonal and cultural dimensions that define quality musical learning experiences.

References:

Bajaj, M., The role of digital learning platforms in enhancing student engagement. Unified Visions: Collaborative Paths In Multidisciplinary Research, 2020. 1

Camlin, D.A. and T. Lisboa, The digital 'turn'in music education. 2021, Taylor & Francis. p. 129-138.

Zou, Y., et al. Digital learning in the 21st century: trends, challenges, and innovations in technology integration. in Frontiers in Education. 2025. Frontiers Media SA

Mhlanga, D., Digital transformation of education, the limitations and prospects of introducing the fourth industrial revolution asynchronous online learning in emerging markets. Discover education, 2024. 3(1): p. 32

Pozo, J.I., et al., Teaching and learning musical instruments through ICT: the impact of the COVID-19 pandemic lockdown. Heliyon, 2022. 8(1)

Merrick, B. and D. Joseph, ICT and music technology during COVID-19: Australian music educator perspectives. Research Studies in Music Education, 2023. 45(1): p. 189-210

Johnson, C., A conceptual model for teaching music online. International Journal on Innovations in Online Education, 2020. 4(2)

Jiang, Q., The impact of Kodály, Orff Schulwerk, and Suzuki music teaching methods on the development of students' musical abilities: A systematic review. Teaching and Teacher Education, 2025. 159: p. 104991

Macrides, E. and C. Angeli. Music cognition and affect in the design of technology-enhanced music lessons. in Frontiers in education. 2020. Frontiers Media SA

Yang, H. Construction and application of smart education teaching platform. in Journal of Physics: Conference Series. 2021. IOP Publishing

Liu, X. and X. Shao, Modern mobile learning technologies in online piano education: Online educational course design and impact on learning. Interactive Learning Environments, 2024. 32(4): p. 1279-1290

Nyamwaka, E.O., Integrating Traditional African Music into Modern Education Using Digital Platform and Artificial Intelligence. LatIA, 2025. 3: p. 320-320

Alshammary, F.M. and W.S. Alhalafawy, Digital platforms and the improvement of learning outcomes: Evidence extracted from meta-analysis. Sustainability, 2023. 15(2): p. 1305

Ma, Y. and C. Wang, Empowering music education with technology: a bibliometric perspective. Humanities and Social Sciences Communications, 2025. 12(1): p. 1-14

Rafiq, S., S. Iqbal, and A. Afzal, The impact of digital tools and online learning platforms on higher education learning outcomes. Al-Mahdi research journal (MRJ), 2024. 5(4): p. 359-369

Anthony Jnr, B., Examining blended learning adoption towards improving learning performance in institutions of higher education. Technology, Knowledge and Learning, 2024. 29(3): p. 1401-1435

Istenič, A., Blended learning in higher education: The integrated and distributed model and a thematic analysis. Discover Education, 2024. 3(1): p. 165

Tang, F., et al., GATFELPA integrates graph attention networks and enhanced label propagation for robust community detection. Scientific Reports, 2025. 15(1): p. 3952

Lam, C.K., Technology-enhanced creativity in K-12 music education: A scoping review. International Journal of Music Education, 2024. 42(4): p. 691-703

Liu, B., et al., Attention non-negative spectral clustering. Knowledge-Based Systems, 2024. 294: p. 111695

Karkina, S., et al. Fostering future music teachers' professional skills: developing a signature pedagogy using e-learning. in Frontiers in Education. 2023. Frontiers Media SA

Stephen, J.S., Instructional Strategies and Assessment Methods in Online Learning: Student Preferences, Perceived Effectiveness, and Usage Patterns in Graduate and Undergraduate Courses. TechTrends, 2025: p. 1-11

Topuz, A.C., et al., Emerging trends of online assessment systems in the emergency remote teaching period. Smart Learning Environments, 2022. 9(1): p. 17

Rakha, A.H. Promoting online teaching through active learning strategies: Applications and innovations. in Frontiers in Education. 2025. Frontiers Media SA

Kong, X. and G. Yue, Construction of embedded online teaching platform based on AES-RSA encryption algorithm. Discover Artificial Intelligence, 2024. 4(1): p. 114

Xia, R., J. Li, and H. Li, The construction of student-centered artificial intelligence online music learning platform based on deep learning. Scientific Reports, 2025. 15(1): p. 15539

Wei, J., M. Karuppiah, and A. Prathik, College music education and teaching based on AI techniques. Computers and Electrical Engineering, 2022. 100: p. 107851

Li, Y. and R. Sun, Innovations of music and aesthetic education courses using intelligent technologies. Education and Information Technologies, 2023. 28(10): p. 13665-13688

Lv, H.Z., Innovative music education: Using an AI-based flipped classroom. Education and Information Technologies, 2023. 28(11): p. 15301-15316

Li, P.-p. and B. Wang, Artificial intelligence in music education. International Journal of Human–Computer Interaction, 2024. 40(16): p. 4183-4192

Yu, X., et al., Developments and applications of artificial intelligence in music education. Technologies, 2023. 11(2): p. 42

Shaw, B.P., Artificial Intelligence and Assessment: Three Implications for Music Educators. Music Educators Journal, 2024. 111(2): p. 19-25

Han, Y., Exploring a digital music teaching model integrated with recurrent neural networks under artificial intelligence. Scientific Reports, 2025. 15(1): p. 7495

Yin, L. and R. Guo, An Artificial Intelligence-Based Interactive Learning Environment for Music Education in China: Traditional Chinese Music and Its Contemporary Development as a Way to Increase Cultural Capital. European Journal of Education, 2025. 60(1): p. e12858

Peng, Y., The analysis of optimization in music aesthetic education under artificial intelligence. Scientific Reports, 2025. 15(1): p. 11545