INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH in PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 14, Issue 4, (2025) E-ISSN: 2226-6348

Exploring AI Applications in Beginner Erhu Instruction through Analysis of Key Instructional Difficulties

Sha Yanlin[1], Yi-Li Chang[2], Zhang Shan Shan[3], Tang Tsiao Yin[4]

[1,2]University of Malaya, Kuala Lumpur, Malaysia, [3]South China Business College, Guangdong University of Foreign Studies, Guangzhou, China, [4]Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia

DOI Link: http://dx.doi.org/10.6007/IJARPED/v14-i4/27039

Published Online: 08 December 2025

Abstract

This study investigates the primary challenges encountered in beginner Erhu instruction through a thematic analysis of current pedagogical literature. Using Braun and Clarke's analytical framework, two overarching themes and their corresponding subthemes were identified: pitch accuracy and rhythmic stability. Within these themes, the review synthesizes factors contributing to intonation instability, common types of rhythmic errors, and associated targeted practice strategies, supported by relevant scholarship. Findings indicate that existing instructional approaches and practice programs remain largely grounded in traditional, teacher-centered paradigms, which may constrain learning effectiveness for many novices. Although conventional methods continue to form the core of Erhu pedagogy, the objective, measurable nature of pitch and rhythm difficulties underscores the potential value of artificial intelligence as a supplementary instructional tool. Overall, this study consolidates key instructional challenges and offers insights that can inform the development of more adaptive and technology-enhanced pedagogical frameworks.

Keywords: Erhu Pedagogy, Pitch Accuracy, Rhythmic Stability, Artificial Intelligence

Introduction

The erhu is a traditional Chinese bowed string instrument whose origins can be traced to the ancient Xi qin. Compared with many Western brass and woodwind instruments, the erhu features a relatively simple physical structure. Its sound is produced through friction between the bow and the strings, which sets the strings into vibration; these vibrations are then transmitted via the bridge to a resonator covered with python skin, where they are amplified. Pitch control and a wide range of right-hand techniques are achieved through direct contact with the strings and continuous adjustments of finger placement. This structural design endows the erhu with remarkable expressive flexibility, granting it distinctive advantages in melodic shaping, timbral variation, and emotional nuance (Chen, 2017; Li, 2022). After a long process of refinement and development, the erhu, renowned for its structural simplicity and expressive versatility, has gained widespread popularity throughout China and global Chinese communities. It has consequently emerged as one of the most representative instruments within the family of traditional Chinese bowed string instruments (Chen, 2007).

Since Liu Tianhua's innovative reforms, which integrated elements of Western and Chinese musical cultures (Yang, 2025), the erhu has gradually shifted from a supporting role to a prominent position on stage. It has evolved from a traditional ensemble-accompaniment instrument into an indispensable solo, chamber, and principal instrument in modern Chinese national orchestras. Against this backdrop, the general public has gained broader exposure to and appreciation for the instrument, leading to a substantial increase in the number of amateur learners seeking to study the erhu. According to data reported by Tao (2021), the market size of erhu education in mainland China reached 3.529 billion RMB in 2015 and continued to grow rapidly, surpassing 5 billion RMB by 2019. Yet even such a sizeable market has not met the demands of all learners, and a pronounced regional imbalance in the distribution of educational resources persists. Large unmet learning needs remain in regions such as Northwest, Southwest, and Northeast China. These figures not only demonstrate the erhu's widespread popularity among enthusiasts but also reveal significant tensions between the rapid expansion of the erhu education industry and the uneven allocation of instructional resources. This widening gap underscores the need for more accessible, adaptable, and pedagogically responsive modes of instruction for beginners.

At the same time, the considerable difficulty involved in learning the erhu is widely acknowledged among scholars. As a bowed string instrument whose sound production relies on friction-induced string vibration, the erhu demands exceptionally refined motor coordination and sustained technical cultivation. Accurate intonation, timbral control, and dynamic regulation all depend on precise muscular adjustments and long-term development of specialized skills (Wang et al., 2021). For instance, the erhu lacks a fingerboard, requiring performers to determine pitch solely through auditory feedback. Moreover, the integrated execution of techniques such as shifting, bowing, and vibrato imposes stringent demands on finger sensitivity and arm stability. Consequently, beginners often experience frustration in the early stages of learning, which can negatively affect their persistence and long-term motivation to continue studying the instrument (China Nationalities Orchestra Society, 2010).

In response to these difficulties, some scholars have attempted to analyze and potentially transform the situation from a pedagogical perspective. Traditional erhu instruction relies heavily on teacher demonstration and student imitation: "Its teaching way is that instructors demonstrate in class and then students memorize bowing and figuring in class and conduct practicing after class. Students then demonstrate their results in class during the next lesson" (Hwang et al., 2019, p. 2). However, it must be emphasized that the demonstration–imitation model itself is not the fundamental source of the problem. The deeper issue lies in the lack of a systematic understanding of the "structure of core challenges" inherent in erhu learning. This problem is also consistent with broader theories of perceptual–motor learning, which emphasize the difficulty of acquiring complex sensorimotor skills when learners receive delayed or ambiguous feedback. The difficulty of learning the erhu does not stem solely from the complexity of its techniques; rather, it arises from intrinsic characteristics of its learning mechanism, which is marked by high perceptual dependence, nonlinear skill progression, and delayed feedback (Ma, 2020).

Beginners, in particular, encounter a "dual uncertainty" in the early stages of learning. The first stems from the absence of immediate and reliable feedback on skills such as intonation and bowing; the second arises from the lack of stable motor and auditory reference frameworks, making it difficult for learners to evaluate whether their practice is effective. This uncertainty creates a substantial "feedback gap" in the learning process, one that cannot be fully compensated for by teacher demonstration alone (Li, 2022; Lian, 2019; Shen & Wei, 2023). Furthermore, traditional demonstration-based instruction implicitly assumes that learners can efficiently extract critical features from multidimensional information within a short period. Most beginners, however, are unable to simultaneously process visual movements, auditory variations, and proprioceptive feedback, resulting in a "can understand but cannot execute" phenomenon that limits the effectiveness of teacher demonstrations.

Existing research provides valuable insights for analyzing the core challenges faced by beginners in erhu instruction. Nevertheless, these studies collectively exhibit certain limitations, including an overreliance on subjective experience, insufficient systematization, and unclear technical pathways (Huang, 2023). Much of the literature focuses on descriptions of technical difficulties, accounts of pedagogical challenges, or summaries of teacher experience, while rarely addressing cognitive mechanisms, structured learning pathways, or skill-decomposition strategies. As a result, although these studies offer a macro-level understanding of where the difficulties lie, they offer limited guidance for developing actionable teaching strategies or quantifiable skill-development plans. This gap signals the need for a more structured conceptual framework that links beginner difficulties to underlying perceptual-motor and instructional processes.

Some scholars have therefore shifted attention to the potential of modern technologies, particularly emerging artificial intelligence, to assist erhu instruction. Drawing on technological applications already implemented in the teaching of Western and Chinese instruments, Jia and Ma (2025) argue that integrating cutting-edge AI technologies into erhu pedagogy represents an inevitable trend. Although AI applications in erhu teaching and performance remain at an early stage, practices established in other instrumental domains suggest that this direction is likely to become a mainstream trajectory for the future development of erhu art and thus holds substantial exploratory value. AI-supported practice systems capable of analyzing pitch, rhythm, and movement patterns may help reduce the feedback gap identified earlier, providing theoretical justification for examining beginner challenges through a lens informed by skill-acquisition and technology-enhanced learning frameworks.

Taken together, these considerations provide the theoretical grounding for this study: beginner erhu difficulties are examined through a combined perspective of perceptual–motor learning theory, feedback theory, and contemporary research on technology-supported music instruction. This framework informs the thematic analysis conducted in the present review. Accordingly, this study addresses the following research question:
What are the key instructional challenges faced by beginner-level erhu learners, and how might these challenges inform the potential application of emerging artificial intelligence technologies in erhu pedagogy?

Literature Review

Research relevant to this study on erhu instruction can generally be grouped into two major areas: analyses of the key instructional difficulties encountered by beginners, and explorations of cutting-edge technological applications in erhu pedagogy (Chao & Karin, 2020; Sharma et al., 2024; Zhou, 2024). Many scholars have examined the fundamental challenges that novice learners commonly face, noting that although difficulties arise in right-hand bowing, left-hand fingering, intonation control, and rhythmic accuracy, pitch accuracy and rhythmic precision consistently emerge as the most critical focal points in beginner-level instruction (Chao & Karin, 2020; Zhou, 2024). Because the erhu lacks explicit left-hand fingering markers, pitch control is widely recognized as a core difficulty for novices (Wu, 2017; Zhou, 2019). As one of the essential components of musical melody, pitch relies heavily on precise finger placement and dynamic adjustments, and even slight deviations can lead to significant intonational errors (Sun, 2018; Wang, 2023). Intonation problems are highly sensitive and potentially disruptive, as unstable pitch, regardless of correct bowing or rhythm, can undermine the overall coherence, expressiveness, and artistic impact of a performance (Tian, 2018; Wang, 2016).

Unstable rhythm is also frequently observed among children and beginners learning the erhu (Hwang et al., 2023). Similar to inaccurate pitch, imprecise rhythm compromises both technical accuracy and musical expressiveness (Chen, 2015). Drawing on practical experience, He (2020) noted that many beginners, lacking a well-developed rhythmic sense, tend to unintentionally stretch or compress musical passages during early learning stages, resulting in performances that deviate substantially from the intended melodic contour. Consequently, developing rhythmic stability is a foundational requirement for novice learners. Overall, both pitch control and rhythmic accuracy represent core challenges in early-stage erhu instruction and addressing them effectively requires coordinated work across classroom teaching, independent practice, and individualized feedback. Such support must be complemented by structured practice strategies and scientific feedback mechanisms to promote technical consistency and steady improvement.

Parallel to these pedagogical discussions, a growing body of research has begun investigating the application of modern computer technologies. especially artificial intelligence in erhu instruction. One of the most notable contributions is the work by Kikukawa et al. (2013), who developed a beginner erhu learning support system that incorporates multiple sensors and computer-assisted technologies. Using a controlled pre-test and post-test experimental design, their study reported positive outcomes, demonstrating that intelligent technologies can partially compensate for the lack of real-time teacher supervision at the beginner level. Their findings also highlighted the potential of data-driven feedback mechanisms to enhance practice quality and reduce the reinforcement of errors, thereby laying important groundwork for future AI-enhanced erhu pedagogy.

Other studies have examined related technological applications. Shen and Wei (2023) reviewed the current practices and limitations of remote online erhu instruction for children and proposed strategies for improvement. Meanwhile, Jia and Ma (2025) and Sun (2025) explored AI-assisted approaches in advanced erhu teaching through case studies of specific repertoire. Although these efforts lack substantial technological innovation, they nonetheless contribute exploratory insights into technology-supported pedagogical development. Taken together, existing attempts to incorporate remote instruction, interactive systems, and AI technologies into erhu pedagogy remain limited in number, depth, and scope. Current research has yet to form a coherent developmental trajectory, and notable gaps persist in areas such as feedback-system design, motion-recognition accuracy, learning-pathway modeling, intelligent assessment, and personalized instruction. These gaps indicate that applications of advanced computing and AI in erhu education, especially at the beginner level, are still insufficiently developed. Targeted technological research grounded in the key challenges faced by beginner learners would therefore help clarify future directions and promote more effective integration and dissemination of intelligent systems in erhu instruction.

Methodology

This study aimed to extend existing research by identifying and synthesizing the objectively observable key challenges in beginner-level erhu instruction and by examining the potential application space of cutting-edge scientific technologies, such as artificial intelligence, within this instructional context. To achieve these aims, Braun and Clarke's (2006) thematic analysis was employed as the core methodological approach. This method was particularly suitable for handling complex, multi-source textual materials and enabled the extraction of meaningful analytical themes without imposing a predetermined theoretical framework, thereby aligning well with the exploratory nature of the study and its intention to summarize developmental characteristics and identify research gaps (Clarke & Braun, 2017).

An inductive, fully data-driven thematic analysis was conducted using NVivo 15 software to analyze literature retrieved through multiple keyword searches. Building upon the literature review, selected studies were systematically coded, categorized, and abstracted to identify recurring concepts, focal issues, and theoretical orientations within the current research landscape. The implementation of the analysis followed Braun and Clarke's six-phase process, which included familiarizing with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final analytic report. Multiple rounds of iterative reading across all included studies were carried out to ensure thorough understanding of both the textual content and the broader research context. Open coding proceeded segment by segment according to inductive principles to minimize the influence of preconceived theories or frameworks. Following initial coding, concepts were consolidated through constant comparison to generate preliminary candidate themes. These themes were repeatedly examined and refined against the literature to ensure that the thematic structure accurately reflected the key issues present in existing research. Throughout the analysis, theoretical interpretation and thematic abstraction relied on the researcher's expert judgment to ensure alignment with the professional context and pedagogical logic of music education.

To support the analytic process, a targeted and systematic literature collection strategy was employed. Major databases, including Google Scholar, CNKI, and Web of Science, were searched using Chinese and English keywords such as "erhu instruction," "beginner-level teaching," "music education technology," "intelligent music learning systems," and "instrumental pedagogy with AI." A wide range of research outputs was included to ensure methodological diversity, encompassing empirical studies, pedagogical investigations, technology-application research, theoretical reviews, as well as relevant conference papers, master's and doctoral theses, and experimental technical reports deemed suitable after quality assessment. Following literature screening, all selected studies were organized and standardized. Key dimensions such as research background, objectives, study participants, technological methods, experimental design, teaching strategies, and research conclusions were recorded and structured through coding to ensure comparability and traceability in the thematic analysis.

NVivo 15 played an essential role in supporting literature management, text annotation, node organization, and data visualization, thereby enhancing the systematicity and transparency of data handling. The resulting thematic structure not only synthesized common viewpoints across existing studies but also revealed research gaps, technological limitations, and potential directions for future development. Through this systematic data-preparation and analytic process, the study established a solid theoretical and empirical foundation for exploring feasible pathways for integrating artificial intelligence technologies into beginner-level erhu instruction.

Findings

Following comprehensive searches of major academic databases, a total of 63 studies addressing core challenges in erhu instruction were initially collected. After organization and screening, 25 studies were excluded due to outdated publication dates, insufficient content depth, or lack of relevance to beginner-level learners, as these criteria did not align with the scope of this study. The remaining body of literature formed the dataset for thematic analysis.

Figure 1
Key themes, sub-themes and codes extracted of the research.

Theme	Sub-Theme	Code	Number of coding reference
Pitch Accuracy	The importance of Pitch Accuracy		43
	Factors Influencing Pitch intonation	Thumb-Index Web Position	6
		Position Shifting	35
		Position of Qianjin (String Loop)	14
		Left-Hand Posture	27
		Inter-Finger Distance	18
		Individual Auditory Differences	23
		Finger Pressure on the String	14
		Bowing Pressure	3
	Effective Approaches for Training Pitch Intonation	Sight-Singing Training	9
		Scale Training	24
		Position-Shifting Training	6
		Hand-Posture Training	8
		Aural Training	6
Rhythmic Accuracy	The importance of Pitch Accuracy		6
	Types of Rhythmic Issues	Rushing	4
		Dragging	4
		Rhythmic Instability	4
	Factors Influencing Pitch intonation	Psychological Factors	6
		Environmental Factors	3
	Effective Approaches for Training Pitch Intonation	Developing Sound Psychological Qualities	6
		Proper Use of Accented Emphasis	5

The analysis revealed that although some scholars discussed techniques such as bowing, vibrato, and tone production, these discussions largely focused on specific repertoire or on intermediate and advanced learners. In contrast, studies explicitly targeting beginner-level erhu instruction overwhelmingly emphasized two core areas: pitch accuracy and rhythmic precision. As shown in Figure 1, which presents the key themes, subthemes, and extracted codes, these two domains repeatedly emerged as the structural foundation of early erhu learning. The literature consistently indicates that beginners first confront the dual challenge of stabilizing intonation and developing rhythmic awareness. If these fundamentals are not secured at an early stage, learners may internalize incorrect motor patterns, leading to accumulated technical obstacles and diminished efficiency in acquiring subsequent left-hand and right-hand techniques. Across the collected studies, pitch and rhythm were therefore framed as indispensable prerequisites for progressing to higher-level technical training.

Within this overall pattern, pitch accuracy appeared as the most frequently cited instructional challenge. Many scholars underscored the erhu's lack of visual reference markers, noting that the instrument's design renders intonation entirely dependent on the performer's finger placement and auditory judgment. Studies such as those by Feng (2018) and Bu and Chen (2018) highlighted pitch control as the most fundamental requirement of erhu performance, while additional research (Sun, 2018; Bai, 2022; Yang, 2015; Chen, 2015) emphasized that accurate intonation constitutes a primary criterion for assessing the performance level of both beginner and intermediate learners. These perspectives collectively demonstrate that pitch acquisition represents a central threshold in erhu training: failure to achieve consistent intonation not only weakens musical expression but also directly impedes the learner's technical progression. Beginners often struggle with this aspect because their auditory discrimination skills remain underdeveloped, and their muscular coordination, particularly fine motor control of the left hand, has yet to stabilize, making pitch acquisition a stage-specific difficulty that frequently generates frustration.

Factors influencing intonation were also well represented across the coded literature. As summarized in Figure 1**,** eight major categories of pitch-influencing factors emerged, with the three most frequently discussed being position shifting, left-hand posture, and individual auditory differences. Studies by Guo (2010), Mao (2024), Wu (1997), and Feng (2018) identified shifting inaccuracy as a major source of pitch drift. Scholars such as Feng (2018) and Wang (2023) further elaborated that poor coordination between the left hand and the thumb–index web, incorrect sequencing of motion, and unstable finger spacing commonly lead to cumulative intonation errors. Meanwhile, research on left-hand posture highlighted the importance of hand relaxation, proper hand shape, and stable instrument-holding posture (Wang, 2023; Mao, 2024; Wang, 2014; Bai, 2022; Li, 2008). Improper posture was found to cause excessive muscular tension, insufficient finger pressure, and reduced clarity in tone production, all of which negatively affect pitch accuracy. Individual auditory differences formed another crucial category: scholars such as Xiao (2007) and Wang (2016) argued that inaccurate intonation ultimately results from misjudgments by the ear, pointing to auditory discrimination as a core determinant of overall learning success. Other pitch-related factors such as thumb–index web placement, inter-finger distance, and bow pressure appeared in the literature but were generally positioned as subcomponents or extensions of the primary factors.

The thematic coding also revealed five commonly proposed approaches for strengthening pitch accuracy, identified across multiple studies. Scale training appeared as the most frequently endorsed strategy, with scholars such as Ying (2016) and Yang (2012) emphasizing its foundational role in internalizing pitch relationships and stabilizing intonation. Recommendations included pairing scale practice with fixed-pitch reference instruments such as the piano to reinforce auditory templates. Additional strategies included sight-singing and aural training to improve interval perception and pitch discrimination (Wang, 2016; Zhang, 2019), as well as position-shifting practice and hand-posture training to consolidate technical consistency and foster reliable muscle memory (Wang, 2014; Yang, 2015).

Parallel to the findings on pitch, rhythmic accuracy emerged as the second major structural challenge highlighted in the literature. Scholars emphasized that rhythm forms the basis of musical coherence; without rhythmic stability, even accurate intonation cannot ensure musical fluency or expressive clarity (Cui, 2017). Existing studies typically classified rhythmic issues into three major types: rushing, dragging, and rhythmic instability. Rushing commonly occurred in fast passages, where dense note sequences induced unintended acceleration (Wei, 1996; Lei, 2020). Dragging appeared frequently in slower sections, especially during syncopated or dotted rhythms where learners often hesitated due to weak rhythmic perception (Cui, 2017; Lei, 2020). When rushing and dragging alternated, performances exhibited rhythmic instability, a compound problem characterized by inconsistent tempo fluctuations.

Unlike pitch-related difficulties, which were often attributed to biomechanical and perceptual factors, rhythmic problems were more frequently associated with psychological influences. Emotional tension and performance anxiety were identified as major contributors to rhythmic errors (Lei, 2020; Wei, 1996). Beginners commonly experienced elevated stress in public performances or even routine classroom demonstrations, leading to tempo distortions. External conditions such as environmental changes, recording contexts, stage attire, or physical setup differences (e.g., bench height) were also reported to exacerbate rhythmic instability among novice players.

The literature offered fewer concrete solutions for rhythmic training compared with pitch-focused approaches. Researchers generally agreed that psychological tension stemmed from insufficient technical mastery and lack of confidence, suggesting that effective remedies require long-term pedagogical development (Wei, 1996; Qian, 1985). Nevertheless, some studies recommended using metric accents strategically to clarify musical phrasing and stabilize tempo, likening accent placement to linguistic punctuation that structures musical flow (Cui, 2017; Wei, 1996).

Taken together, the themes identified through the literature demonstrate a clear and consistent emphasis on pitch accuracy and rhythmic stability as the foundational challenges confronting beginner erhu learners. These findings provide a consolidated basis for understanding structural learning difficulties and highlight key pedagogical areas in which targeted training methods and technological support, including emerging AI tools, may hold significant potential for future instructional development.

Discussion

The thematic analysis conducted in this study demonstrates that pitch accuracy and rhythmic stability are consistently identified in existing literature as the central challenges in beginner-level erhu instruction. Although traditional pedagogical strategies proposed by erhu educators draw on extensive teaching experience, they remain grounded in conventional instructional models. Whether delivered through one-to-one lessons or group-class formats, these approaches rely heavily on the expertise and real-time evaluative judgment of highly skilled instructors (Zhao, 2019). Yet such instructional resources are not readily accessible to most beginners, resulting in a persistent gap between learners' needs and the availability of high-quality, individualized guidance.

This gap raises an important question: whether modern computer-based technologies can provide more stable, objective, and immediate feedback for novice learners. Although the present study focuses on teaching challenges identified in traditional pedagogical literature, the intrinsic characteristics of these challenges, being quantifiable, repetitive, and closely tied to auditory perception, suggest promising opportunities for technological intervention. As reflected in the findings, common beginner difficulties such as basic intonation deviations, inconsistent finger placement during position shifts, and rhythmic issues including tempo acceleration, delay, or instability all fall within the analytical capacity of contemporary audio signal–processing algorithms. Existing research on AI-supported assessment systems for violin performance, fingering detection, and practice feedback illustrates the technical feasibility of such applications (Li, 2023; Zhang, 2022; Wang & Fitri bin Haris, 2025; Salvi et al., 2021). From this perspective, integrating artificial intelligence and digital audio technologies into the erhu learning environment could potentially provide new pathways for addressing these structural pedagogical challenges.

Nevertheless, it is necessary to approach technological applications with caution, particularly given the current absence of widely adopted AI-assisted tools for instrumental instruction. The erhu's nuanced timbre, flexible expressive techniques, and the interpretive judgment required of trained instructors in areas such as musical aesthetics, movement evaluation, and stylistic shaping remain beyond the full reach of existing technologies. For this reason, technology should be viewed as a complement rather than a replacement for traditional instruction. Its value lies in offering structured, immediate, and repeatable feedback during learners' daily practice—especially in contexts where high-quality instructional resources are limited or where self-practice lacks effective supervision.

In summary, the two major instructional difficulties identified in this study provide a clearer understanding of the structural features of beginner-level erhu teaching and simultaneously highlight potential avenues for technological enhancement. As artificial intelligence and music-education technologies continue to evolve, an important direction for future research is the design of auxiliary tools that align with the physical and musical characteristics of erhu performance while directly addressing the core training challenges faced by novice learners.

Conclusion

The findings of this study demonstrate that pitch accuracy and rhythmic stability constitute the two most fundamental and persistent challenges faced by beginner-level erhu learners. Through thematic analysis of existing literature, these elements emerged not only as technical difficulties but also as structural barriers that shape the trajectory of early-stage skill development. Addressing them effectively is essential for ensuring smooth progression into more advanced left-hand and right-hand techniques, as well as for preventing the consolidation of maladaptive motor patterns.

The results also highlight the continued dominance of traditional pedagogy in erhu instruction, which relies heavily on expert teachers for real-time evaluation and corrective guidance. While such expertise is irreplaceable in areas requiring nuanced aesthetic judgment, the widespread lack of access to high-caliber instruction reveals a substantial gap between learners' needs and available resources. This pedagogical imbalance underscores the practical importance of exploring supplementary forms of instructional support, especially those capable of offering stable, immediate, and repeatable feedback during daily practice.

The implications of these findings point toward the growing relevance of technological intervention, particularly artificial intelligence, digital audio analysis, and motion-recognition systems, in supporting early-stage erhu learning. Because many beginner-level errors in pitch and rhythm are quantifiable and highly repetitive, these domains align well with the analytical strengths of computer-based systems. Thoughtfully designed technological tools could help democratize access to effective practice feedback, reduce the accumulation of technical errors, and enhance learning efficiency in contexts where traditional supervision is limited.

Building on this foundation, future research should focus on the systematic design, validation, and refinement of AI-assisted tools that align with the expressive and technical characteristics of erhu performance. Potential research directions include developing intelligent pitch- and rhythm-assessment systems, modeling individualized learning pathways, improving motion-recognition accuracy for left-hand and bowing techniques, and evaluating the pedagogical effectiveness of hybrid (teacher–AI) instructional models. Longitudinal and experimental studies will be particularly valuable for determining how technological interventions influence learning outcomes, motivation, and long-term skill acquisition among novice erhu learners.

References

Bai, Q. Y. (2022). Research on pitch issues in erhu performance. Xiju Zhijia, (17), 93–95.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bu, X. M. (2016). Reflections on pitch training in erhu teaching. Mingri Fengshang, (23), 253+244.

Bu, X. M., & Chen, J. (2018). Common rhythm problems in current erhu teaching and solutions. Yishu Jiaoyu, (07), 66–67.

Chao, Z., & Karin, K. (2020). Analysis of the innovative ideas of erhu teaching in Chinese universities. *Oxidation Communications*, *43*(1).

Chen, K. (2007). The historical origins of the erhu and similar instruments. National Art, 3, 52–57, 86. https://doi.org/10.16564/j.cnki.1003-2568.2007.03.012

Chen, S. (2015). Problems and solutions in children's erhu learning. Heilongjiang Education (Theory and Practice), 12, 46–47.

Chen, X. (2017). A comparison of Qin Pai and Jiangnan Pai erhu performance practice based on Qinfeng and Jiangnan Chunse (Master's thesis, University of Malaya, Malaysia).

Clarke, V., & Braun, V. (2017). Thematic analysis. The Journal of Positive Psychology, 12(3), 297–298. https://doi.org/10.1080/17439760.2016.1262613

Cui, Y. H. (2017). Rhythm problems and solutions in erhu performance. Huanghe Zhisheng, (05), 94. https://doi.org/10.19340/j.cnki.hhzs.2017.05.069

Feng, Q. L. (2018). Pitch issues in shifting positions on the erhu (Master's thesis, Shanxi University).

https://180.76.102.59:9299/kcms2/article/abstract?v=ewTrO3D4JaO5mVSNMHU3m_Xz43oKteH330UKATybEgQUX6oUf9aLgUagHafAswqkyeibKGr6ru_PwTOK2o_9KAnMoUHGlG2CV_yeHFDhr_gm68Ihywab_E3mRXSUmMZb3dq2jUIxNUeWSjCaoE54k3ezLGv-NSwlRJEjOuioTRWKXXttUpRrXQ==&uniplatform=NZKPT&language=CHS

Guo, X. L. (2010). Several issues to note in beginner erhu learning. Huanghe Zhisheng, (23), 30–31.

Hao, Y. (2020). A study on the reform of erhu teaching models in higher vocational colleges in the "Internet+" era. Northern Music, 8, 189–190. https://doi.org/CNKI:SUN:BYYY.0.2020-08-112

Hwang, G.-H., Chen, B., & Sung, C.-W. (2019). Impacts of flipped classrooms with peer assessment on students' effectiveness of playing musical instruments – taking amateur erhu learners as an example. Interactive Learning Environments, 27(8), 1047–1061. https://doi.org/10.1080/10494820.2018.1481105

Hwang, G. H., Ping-Tsung, T. S. A. I., Jenn-Kaie, L. A. I. N., & Huang, S. H. (2023, December). Development and Usability Evaluation of an Intelligent Personalized Erhu Pitch and Rhythm Learning System. In *International Conference on Computers in Education*.

Huang, H. (2023). Thoughts on the current situation and drawbacks of basic erhu teaching. Theatre Home, 33, 187–189. https://doi.org/CNKI:SUN:XJZT.0.2023-33-061

Huang, H. Q. (2023). Pitch problems and solutions in erhu performance. Xiju Zhijia, (36), 97–99.

Huang, Y. Y. (2008). Exploration of pitch training in erhu. Juying Yuebao, (04), 106–107.

Kikukawa, F., Ishihara, S., Soga, M., & Taki, H. (2013). Development of a learning environment for playing erhu by diagnosis and advice regarding finger position on strings. In Proceedings of the International Conference on New Interfaces for Musical Expression (pp. 271–276).

Li, C. (2022). A systematic review on erhu. Frontiers in Art Research, 4(11). https://doi.org/10.25236/FAR.2022.041104

Li, J. (2023). Advancing violin pedagogy through biomedical-inspired AI: A digital technology-assisted approach to violin teaching. Journal of Commercial Biotechnology, 28(2).

Li, L. (2008). On pitch and rhythm control in erhu performance. Yinyue Tansuo, (03), 106–108+112. https://doi.org/10.15929/j.cnki.1004-2172.2008.03.023

Lian, Z. (2019). A reflection on the intonation in erhu performance. Bulletin of Social, Economic, and Humanitarian Research, 4(6), Article 4(6).

Liu, J. X. (1986). Investigation into erhu pitch. Renmin Yinyue, (01), 18–22.

Ma, L. C. (2016). Pitch problems in youth erhu teaching. Kecheng Jiaoyu Yanjiu, (25), 199.

Ma, X. D. (2020). Design and implementation of violin practice supervision and evaluation system (Master's thesis, Beijing Jiaotong University). https://doi.org/10.26944/d.cnki.gbfju.2020.003744

Ma, G. (2020). The influence of transplanting Western music works on erhu techniques and skills (Master's thesis, China Conservatory of Music). https://doi.org/10.27654/d.cnki.gzgyc.2020.000102

Mao, S. L. (2024). Erhu performance pitch issues and solutions. Canhua, (34), 68–70.

Qian, Z. H. (1985). Beat, rhythm, and tempo in erhu performance. Zhongguo Yinyue, (01), 61–62.

Ren, J. (2017). The role of basic skill training in erhu teaching. Jiaoyu Wenhua Luntan, 9(04), 75–78. https://doi.org/10.15958/j.cnki.jywhlt.2017.04.017

Salvi, D., Gonzalez, S., Antonacci, F., & Sarti, A. (2021). Parametric optimization of violin top plates using machine learning. arXiv preprint arXiv:2102.07133.

Sharma, A., Yadav, A., Singh, H., Ranjan, V., Joshi, N., & Hazara, D. (2024, November). Harmonizing Tradition with Innovation: A Deep Learning-Powered Personalized Erhu Teaching Experience. In *2024 International Conference on IoT, Communication and Automation Technology (ICICAT)* (pp. 1524-1528). IEEE.

Shen, C., & Wei, L. L. (2023). The application of online education in children's erhu teaching. Music, Education, and Creation, 10, 31–34. https://doi.org/CNKI:SUN:YYJC.0.2023-10-007

Sun, C. F. (2020). Exploration of pitch issues in erhu performance. Dangdai Yinyue, (12), 121–123.

Sun, M. X. (2018). Analysis of pitch issues in erhu performance. Dazhong Wenyi, (12), 115. https://doi.org/10.20112/j.cnki.issn1007-5828.2018.12.167

Su, S. T. (2016). Techniques for controlling pitch in erhu performance. Juying Yuebao, (02), 66–68.

Tao, J. (2021). Research on erhu training market, integrated marketing communication model, and industry development strategy [Master's thesis, Hainan University].

Wang, W. (2016). Sight-singing and ear training in erhu teaching. Beifang Yinyue, 36(20), 104.

Wang, W. D. (2014). Influencing factors and improvement approaches for pitch in erhu performance. Dati Tai, (08), 159–160. https://doi.org/10.15947/j.cnki.dwt.2014.08.042

Wang, X. Y. (2023). Analysis of pitch issues in basic erhu practice (Master's thesis, Shanxi University). https://doi.org/10.27284/d.cnki.gsxiu.2023.002049

Wang, X., & Fitri bin Haris, M. (2025, March). AI-driven violin performance evaluation: A deep learning approach for automated assessment and personalized feedback in music education. In Proceedings of the 2025 International Conference on Generative Artificial Intelligence and Digital Media (pp. 126–132).

Wei, P. Z. (1996). Rhythm problems and solutions in erhu performance. Huanghe Zhisheng, (06), 22–24.

Wu, W. (2017). A study on the teaching methods of children's erhu. Theatre Home, 20, 179, 209. https://doi.org/CNKI:SUN:XJZT.0.2017-20-130

Wu, X. Y. (1997). Pitch issues in erhu teaching. Yancheng Shizhuan Xuebao (Renwen Shehui Kexue Ban), (03), 99–101.

Xu, J. C. (2021). Reflections on children's erhu teaching. Xiju Zhijia, (26), 109–110.

Yang, L. (2012). On "hearing the right pitch" in erhu practice. Dazhong Wenyi, (16), 17. https://doi.org/10.20112/j.cnki.issn1007-5828.2012.16.021

Yang, L. J., & Sun, X. D. (2009). Some reflections on pitch in erhu. Shidai Wenxue (Second Half Month), (08), 208.

Yang, Y. (2015). Exploration of pitch issues in erhu performance (Master's thesis, Jilin Academy of Arts). https://180.76.102.59:9299/kcms2/article/abstract?v=ewTrO3D4JaMyBzzR2L03bP6sl87YkuDpJOKG28uwYyNL75FELmLRIgxZiGVEYlyvNYDzxeTafOzmQKmyPOlH50IHJPFOuQtMxFjnwjS7lhTMeeTs4yb2JDL7gExrecka8u_CgO8JT5exGvEtsvIdld_JoGMSngpp7LDNmp62QcS5vVMJF9PJSQ==&uniplatform=NZKPT&language=CHS

Zhang, Y. Q. (2019). Reflections on pitch problems in erhu teaching. Huanghe Zhisheng, (24), 32–34. https://doi.org/10.19340/j.cnki.hhzs.2019.24.015

Zhao, W. (2019). A study on cultivating children's interest in erhu learning [Master's thesis, Shandong Normal University].

Zhou, L. (2024). Construction and Practice of Erhu Performance Course for Musicology Majors in Local Universities—A Case Study of Sichuan Minzu College. *Frontiers in Educational Research*, *7*(2), 71-75.

Zhou, Y. (2019). A study on the current situation and development strategies of children's erhu teaching in Gaoyou City [Master's thesis, Yangzhou University]. https://link.cnki.net/doi/10.27441/d.cnki.gyzdu.2019.000909