



A Study on Design Methods for Cultural Heritage Educational Games: A Case Study of the Bainiao Chaofeng Gongche Notation

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Abstract. In the context of digitalization, the transmission of traditional music as Intangible Cultural Heritage (ICH) faces challenges such as declining performance contexts and limited engagement among younger audiences. Existing studies indicate that while digital media and gamification can enhance learning engagement, most approaches remain focused on general educational applications, lacking systematic methods for integrating musical structure and cultural meaning into interactive design. Therefore, this study asks: how can traditional music, particularly Gongche notation¹, be transformed into an interactive educational game that supports both musical understanding and cultural cognition?

To address this question, this research proposes a design methodology for cultural heritage educational games, structured across three dimensions: cultural content, game mechanics, and interactive experience. Taking the Gongche notation of Hundred Birds Paying Homage to the Phoenix² as a case study, the research explores the transformation of musical elements into interactive forms through rhythmic interaction, audiovisual feedback, and narrative context.

The results demonstrate that embedding musical structure into gameplay promotes active participation and enhances both engagement and comprehension. This study provides a structured approach for integrating traditional music into interactive media, contributing to the digital dissemination and educational application of ICH.

Keywords: Intangible Cultural Heritage, Educational Games, Game Design, Hundred Birds Paying Homage to the Phoenix (Baibiao Chaofeng) Gongche Notation.

- 1 Gongche notation is one of the traditional systems of musical notation in China. It employs characters such as "Gong," "Chi," "Shang," "Si," "Wu," "Liu," and "Yi" to represent relative pitches, and is primarily used for the documentation and transmission of traditional opera and folk music.
- 2 Bai Niao Chao Feng (Hundred Birds Paying Homage to the Phoenix) is a quintessential work in the traditional suona repertoire. Employing onomatopoeia to mimic the calls of birds, it evokes the musical imagery of "a hundred birds singing in unison." Characterized by its rich structure and diverse techniques, the piece possesses significant artistic merit and serves as a highly representative example of the genre.

1 Introduction

Against the backdrop of digitalization and globalization, the transmission of Intangible Cultural Heritage (ICH) faces both opportunities and challenges. Traditional music, reliant on ritual contexts and oral transmission, is increasingly constrained by shifting cultural environments and youth preferences. Qinyang Suona Art, listed as national ICH in 2006, has long been rooted in local life, with Hundred Birds Paying Homage to the Phoenix as a representative piece.^[1] however, its mastery requires extensive practice, limiting broader dissemination.

Although digital media have expanded dissemination channels, they remain largely passive and lack interactivity. In response, this study proposes a design methodology for cultural heritage educational games, using the Gongche notation of Hundred Birds Paying Homage to the Phoenix to explore interactive approaches to traditional music learning in a digital context.

2 Theory and Current Status

2.1 Cultural Heritage and Music Education

Against the backdrop of digitalization and artificial intelligence, transforming traditional cultural forms has become key to the development of Intangible Cultural Heritage (ICH).^[2]Traditional music, rooted in folk contexts, relies on oral transmission and participatory practice.

Qinyang Suona art, developed through the integration of imported instruments and local traditions, originated from the“Qinyang Guanzi.”It evolved from court to folk contexts and was further enriched through inter-regional exchange. Bai Niao Chao Feng stands as a representative piece, characterized by lyrical melody and birdsong imitation.^[3]Its performance demands both technical skill and a deep understanding of cultural meaning.(see Fig. 1)



Fig. 1. Analysis of the Characteristics of *Song of the Phoenix*

With the decline of traditional contexts and changing lifestyles, learners have limited access to authentic environments, and traditional music learning has shifted toward notation systems and digital media. Although online platforms broaden access, they remain largely passive and lack interactivity.

Thus, developing participatory learning approaches suited to contemporary media—while preserving cultural essence—has become a key issue, laying the foundation for transforming traditional music into interactive experiences.

2.2 Educational Games and Interaction Design

Amid declining traditional learning pathways and the limitations of unidirectional dissemination, introducing interactive and participatory experiences has become crucial for cultural transmission. Compared to passive listening, gamification enhances engagement and immersion by embedding learning within tasks and interaction, enabling learners to construct knowledge through participation.^[4]

Educational games are not merely entertainment but goal-oriented interactive designs that transform knowledge into actionable gameplay.^[5] By shifting learners from passive recipients to active participants, they support “learning by doing,” aligning with the practice-based nature of music learning.^[6] From a theoretical perspective, the design of educational games should be supported by established learning and motivation theories. Self-Determination Theory (SDT) emphasizes that autonomy, competence, and relatedness are key factors in sustaining learner motivation, which can be reflected in game design through player choice, progressive challenges, and feedback systems.^[7] Meanwhile, Cognitive Load Theory (CLT) highlights the need to balance information complexity and cognitive processing capacity, suggesting that interface design and interaction mechanics should reduce extraneous load while supporting schema construction.^[8] These theories provide a foundation for designing interactive systems that are both engaging and cognitively effective.

However, systematic design methods for applying educational games to traditional music remain underdeveloped, particularly in integrating cultural meaning and symbolic elements into game mechanics. In response, this study explores transforming traditional music into interactive game experiences and proposes a design methodology for cultural heritage educational games.

3 Framework Design

3.1 Overall Framework Structure

Centered on the Gongche notation of Hundred Birds Paying Homage to the Phoenix (Bai Niao Chao Feng), this study constructs a design framework based on the sequence “Notation Conversion—Rhythmic Interaction—Experiential Generation” to explore its application in educational games. The notation is restructured into an interactive rhythm-game interface by translating pitch and rhythm into elements such as note tracks, rhythmic nodes, and sectional divisions, forming a readable and operable

system. Interaction methods including tapping, swiping, and long-pressing correspond to performance rhythms, creating an “Audition—Action—Feedback” loop.

In terms of experience, the design extends beyond chart completion by incorporating visual variations aligned with musical sections. Bird-call imitations are expressed through dynamic visuals, fostering a cultural atmosphere and guiding players from mechanical interaction toward understanding musical mood and meaning. The framework operates across three layers: notation as visual rules (“how to read”), performance as interaction (“how to play”), and cultural imagery as expression (“how to feel”), forming an integrated experience.

Overall, rather than replicating performance, the framework reorganizes musical structure within a game context, providing a foundation for interface and interaction design.(see Fig. 2)

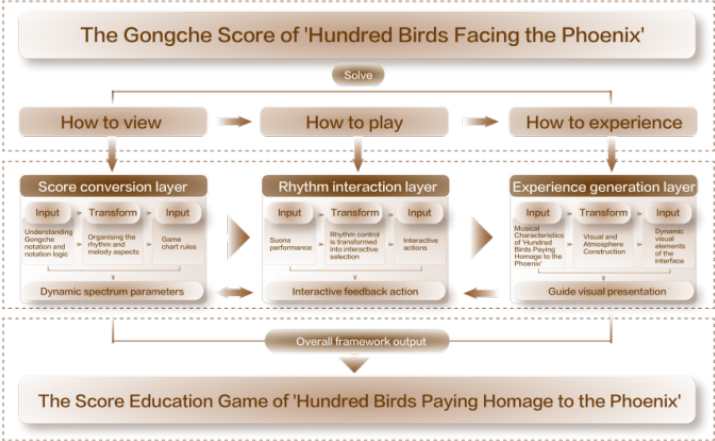


Fig. 2. Overall Structural Framework Design

3.2 Cultural Content Adaptation

In educational games, the Gongche notation of Bai Niao Chao Feng is embedded in the learning process rather than simply made playable, structuring learning as “comprehension–operation–internalization.” The notation is organized into three layers: a Basic Layer (pitch, rhythm) for interface foundation, an Advanced Layer (phrases, sections) for progression, and an Extended Layer (form, onomatopoeia) for contextual guidance. This structure aligns operational difficulty with cognitive depth, linking simplified symbols to authentic notation and integrating reading with performance.

Through rhythmic evaluation, sectional feedback, and embedded structural cues, players gradually grasp musical structure and meaning. Overall, the framework integrates learning into core mechanics via a closed loop of “notation—interaction—feedback,” supporting understanding of both musical structure and cultural significance.

3.3 Game Mechanics and Interaction Design

In educational games, design must balance “engagement” and “learning.” Based on rhythm-tapping mechanics, the game differentiates patterns through note shapes and colors, linking player actions to metrical structure. As levels progress, visual cues gradually fade, guiding players from visual reliance to internal rhythm. Difficulty advances from simple imitation to phrase recognition and complex combinations, aligning with learning progression.

A dual feedback system is designed to bridge operational performance and structural understanding. At the operational level, immediate feedback is provided through timing judgments, sound responses, and visual effects, allowing players to adjust their actions in real time. At the cognitive level, structural feedback is embedded through sectional cues, phrase segmentation, and pattern repetition, guiding players to recognize musical organization beyond isolated actions.

Specifically, visual markers and rhythmic grouping highlight phrase boundaries, while recurring patterns reinforce memory of musical structures. As gameplay progresses, explicit visual guidance is gradually reduced, encouraging players to internalize rhythm and structure. This transition from external feedback to internalized understanding supports the development of cognitive schemas, enabling players to move from mechanical interaction to structural comprehension of the music.

4 Case Study: Hundred Birds Paying Homage to the Phoenix
Gongche Notation Educational Game

In transforming traditional music into educational games, a key challenge is translating musical structure into interactive forms. Compared to the fixed Western staff, Gongche notation emphasizes relative pitch and rhythmic flexibility, offering greater design potential. It can be deconstructed into four dimensions—pitch, rhythm, performance, and emotion—forming a framework of “pitch mapping,” “rhythmic representation,” “performance guidance,” and “expressive characteristics.” (see Fig. 3)

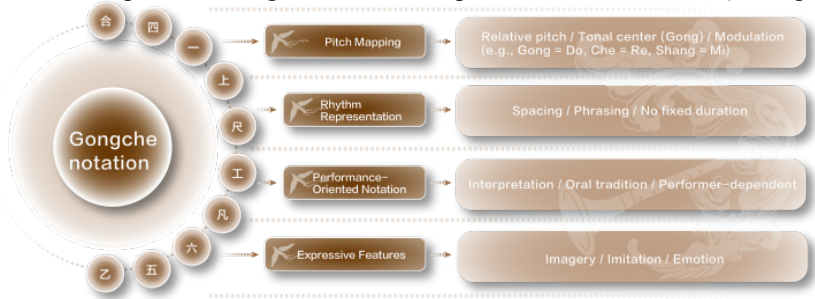


Fig. 3. Gongche Musical Elements–Interaction Diagram

To validate the effectiveness of the Bai Niao Chao Feng Gongche notation educational game, this study systematically analyzes the functions of its modules and establishes correspondences among “system modules,” “content input,” “mechanism

design,”and“evaluation metrics.”(see Table 1), serving as the foundational basis for subsequent validation.

Table 1. Practical Validation Form for Bai Niao Chao Feng Educational Game

System Modules	Content Input	Mechanism Design	Evaluation Metrics
Level Scheduling Module	Melody and Structure	Segmentation and Progression	Structural Accuracy (Subjective Scale)
Interface Rendering	Gongche Symbols and Pitch	Visual Symbols and Motion	Notation Recognizability (Memory Test)
Interactive Control Module	Rhythm and Breath Control	Tap, Swipe, and Hold Inputs	Rhythm Sync Evaluation (Backend Operational Data)
Visual Feedback Module	Onomatopoeia and Artistic Mood	Dynamic Visual Effects	Cultural Ambience Perception (Post-Experience Interview)

The modules progress from understanding to operation to perception, shifting learning from knowledge acquisition to cultural experience. This demonstrates that integrating Gongche notation into game mechanics enhances engagement and supports the contemporary expression of traditional music.

5 Conclusion

Centered on the integration of Intangible Cultural Heritage (ICH) and educational games, this study proposes a design methodology for cultural heritage learning, using the Gongche notation of Hundred Birds Paying Homage to the Phoenix as a case. It explores transforming traditional music into interactive experiences.

Based on the contextual and practice-oriented nature of traditional music learning, the design is structured across cultural content, game mechanics, and interactive experience. Musical elements such as rhythm, melody, and onomatopoeia are incorporated into interactive forms with feedback, promoting a shift from passive reception to active engagement.

The case shows that embedding traditional music in game mechanics enhances immersion and supports understanding of musical structure and cultural meaning. As an exploratory study, future work may include user testing and immersive technologies to expand its application.

References

1. Han Yi.,Li Guosheng.: Qinyang: The Art of the Suona. Henan People's Publishing House, Zhengzhou (2016) <http://book.ucdrs.superlib.net/views/specific/2929/bookDetail.jsp?dxNumber=000017860054&d=DCFFD9327578E3969913CCFD14F87D14&fenlei=100904010104>

2. Qi Yongguang.,Hong Haoran.: "Remediation: A Study on Innovative Communication of Excellent Traditional Chinese Culture in the Digital-Intelligence Era."Journal of Journalism and Communication Review[J]. 17 (2026) DOI:10.14086/j.cnki.xwycbpl.2026.02.002.
3. Wei Zhiguo.: Analysis of Performance Techniques in the Suona Piece Hundred Birds Paying Homage to the Phoenix[D]. North University of China,Taiyuan16 (2022) DOI:10.27470/d.cnki.ghbgc.2022.001104.
4. Oliveira, W.; Hamari, J.; Shi, L.; Toda, A.M.; Rodrigues, L.; Palomino, P.T.; Isotani, S.: Tailored gamification in education: A literature review and future agenda. Educ. Inf. Technol[J]. 373–406 (2022) DOI:10.1007/S10639-022-11122-4
5. Mostafa Osama Mostafa Abdulrazic, Mirza Rayana Sanzana, Kher Hui Ng. Design, implementation, and user evaluation of a no code 3D serious game authoring tool for cultural heritage education[J]. Discover Education, 2026, 5 (1):3 DOI:10.1007/S44217-026-01162-0
6. Ahmad Almufarreh. Gamification in Education and Its Impact on Student Academic Performance: A Conceptual Model Based on Systematic Literature Review and PLS-SEM Analysis[J]. Algorithms, 2026, 19 (2):23 DOI:10.3390/A19020143
7. Sun Xiaoxia.,Fan Zilin.:Research on Digital Nomad Role Exit Based on Self-Determination Theory.Journal of Tourism[J]. 3 (2026) <https://link.cnki.net/urlid/11.1120.k.20260319.1454.002>.
8. Gao Ziyi.:Research on Museum Educational Game Design from the Perspective of Cognitive Load Theory[D]. Jiangnan University, Wuxi6-7(2024). DOI: 10.27169/d.cnki.gwqgu.2024.000825

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