# Local Cultural Governance and Educational Innovation: A Mobile Learning Model for the Traditional Instrument Khong Wong Yai in Thailand

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## ABSTRACT

This article explores how digital mediation reshapes the transmission of Thai traditional music through the case of the Khong Wong Yai learning application. Developed during the COVID-19 pandemic, the application addresses issues of accessibility, inequality, and the sustainability of cultural education. Grounded in ethnographic observation and participatory design, the study integrates a usability evaluation (SUS = 84.2) with qualitative feedback from students and instructors of the MSE 214 Khong Wong Practicum course. Findings reveal that digital simulation not only supports self-directed practice but also reconfigures the embodied learning of rhythm, timbre, and melodic contour characteristic of Thai classical performance. Users reported improved understanding of tonal structure and cultural meaning, suggesting that technology can mediate between traditional apprenticeship and contemporary modes of learning. The article argues that such digital interfaces function as new cultural spaces where heritage, pedagogy, and identity converge—demonstrating the potential of digital innovation to sustain musical heritage and foster social change in modern Thailand.

**Keywords:** Digital Mediation; Cultural Transmission; Thai Traditional Music; Musical Heritage; Social Change

## INTRODUCTION

Thai traditional music, long transmitted through oral practice and apprenticeship, represents not only a form of aesthetic expression but also a system of cultural continuity. Within this system, the *Khong Wong Yai* —a circular set of tuned gongs—holds a central role in the *piphat* and *mahori* ensembles, serving as both the rhythmic and melodic foundation of performance (Morton 1976: 34; Miller and Williams 2008). The learning of this instrument traditionally depends on intimate teacher–student relationships, imitation, and repetition, where musical knowledge is embodied rather than textualized. However, in the twenty-first century, the rapid expansion of digital technologies and the social transformations accelerated by the COVID-19 pandemic have profoundly altered these modes of transmission (OECD 2020).

The pandemic exposed long-standing structural inequalities in cultural education, particularly within fields that depend on physical practice. Students without access to instruments or in-person instruction faced significant interruptions in their learning processes. In Thailand, this gap highlighted a tension between preserving cultural authenticity and ensuring equitable access to traditional music training. The crisis therefore opened a broader question about how intangible heritage can be sustained and transmitted in a digitally mediated environment (UNESCO 2019).

In response to these challenges, educators and researchers have begun to explore digital technologies not only as tools for distance learning but also as new cultural spaces where practices of music, identity, and pedagogy are reconfigured (Born 2005; Yúdice 2020). These digital mediations allow traditional music to circulate beyond its

local contexts, entering transnational networks of cultural consumption and re-creation. Yet they also raise questions concerning authenticity, embodiment, and the materiality of musical experience (García 2019).

The *Khong Wong Yai Learning Application*, developed as part of an applied research project at Srinakharinwirot University, emerged from this intersection of crisis and innovation. Designed as a mobile-based simulation compatible with iOS and Android, the application enables learners to experience the sonic structure and performance gestures of the instrument through touchscreen interaction. While the project initially sought to address practical limitations in access to instruments, it has since evolved into a platform that reflects larger issues of cultural reproduction and adaptation in the digital age.

The *Khong Wong Yai Learning Application* was developed as part of a university-funded applied research program at Srinakharinwirot University focused on creating mobile learning applications for Thai traditional instruments **(Metee, 2021)**. The *Khong Wong Yai* application represents one component of this larger initiative, which emerged from the intersection of crisis and innovation during the COVID-19 pandemic. Designed as a mobile-based simulation compatible with iOS and Android, the application enables learners to experience the sonic structure and performance gestures of the instrument through touchscreen interaction. While initially addressing practical limitations in instrument access, the project has evolved into a platform that reflects larger issues of cultural reproduction and adaptation in the digital age.

By analyzing users' experiences, learning outcomes, and perceptions of authenticity, this article contributes to a growing body of research that views digital innovation as an active participant in cultural processes rather than a neutral medium (Born 2005; García 2019; Yúdice 2020). It argues that the *Khong Wong Yai* learning application exemplifies how cultural heritage can be transmitted, transformed, and reimagined through technological mediation, offering insights into the evolving dynamics of Thai musical culture in the cont

## THEORETICAL FRAMEWORK: CULTURE, TECHNOLOGY, AND TRANSMISSION

The intersection of culture and technology has long been a focus of cultural sociology and media anthropology. In the study of music, this relationship is particularly pronounced because sound, as a medium of embodied expression, carries both technical and symbolic dimensions. As Born (2005) observes, musical practices are sites of "mediation," where creativity and social relations are shaped by the material and technological conditions of production. This notion of musical mediation provides a critical entry point for understanding how digital technologies reshape the ways traditional music is transmitted, learned, and experienced in contemporary Thailand.

Within the broader framework of cultural production (Bourdieu 1984), music functions not only as art but as a form of cultural capital that reinforces and transforms social hierarchies. The *Khong Wong Yai*, as part of Thailand's classical music tradition, historically signifies status, discipline, and communal identity. The transition of this instrument into a digital environment thus entails more than technical adaptation; it reconfigures access to cultural capital, allowing new groups—students without instruments, non-musicians, and global audiences—to participate in musical heritage (García 2019). This digital redistribution of access embodies what Appadurai (1996) terms "cultural flow," the movement of ideas, practices, and identities across boundaries of class and geography.

Digital learning applications mediate these flows through what Yúdice (2020) describes as "cultural platforms," infrastructures that both reproduce and transform the meanings of culture. In this sense, the *Khong Wong Yai* application does not merely digitize the instrument; it recontextualizes Thai musical pedagogy within the logic of contemporary media—interactivity, simulation, and mobility. Learners engage with the instrument not through imitation of a master alone but through touchscreen interaction that translates physical gestures into sound, forming a new type of embodied learning (Shusterman 2022). The body, as much as the screen, becomes a site where cultural transmission is reimagined through digital sensory experience.

This study also draws on UNESCO's (2019) framework for intangible cultural heritage, which emphasizes the dynamic processes of safeguarding living traditions. According to this perspective, preservation does not imply static conservation but involves adaptation to contemporary contexts. Digital mediation thus serves as a tool of "living heritage," where technology sustains, rather than replaces, traditional practices. As observed in recent ethnomusicological research, such digital transformations can enhance participation while raising questions of authenticity and ownership (De Luca and Vassallo 2021; Kim 2019).

In the context of education, the Technological Pedagogical Content Knowledge (TPACK) model (Mishra and Koehler 2006) provides a useful lens for understanding how teachers integrate technology with disciplinary knowledge. Applied to Thai music, this framework illuminates how digital tools like the *Khong Wong Yai* app support both cognitive and affective dimensions of learning. Students acquire not only factual knowledge—note sequences, rhythmic patterns—but also a sensorial connection to the instrument's tonal character. This process aligns with theories of self-regulated learning (Zimmerman 2002; Cho and Cho 2017), wherein learners take active responsibility for their engagement and progress.

Bringing these perspectives together, this article conceptualizes digital mediation as a cultural bridge—a process that both preserves and transforms heritage. It involves multiple layers of interaction: the technological (interface and simulation), the pedagogical (learning processes), and the sociocultural (meaning and identity). Through this framework, the *Khong Wong Yai* learning application can be seen as a microcosm of social change, illustrating how traditional arts evolve through technological environments while maintaining their symbolic integrity.

In summary, this study positions the integration of Thai traditional music and mobile technology within a triadic theoretical framework:

**Cultural Mediation** (Born 2005; Yúdice 2020): explaining how technology becomes a medium through which musical meaning and social relations are reshaped;

**Cultural Capital and Transmission** (Bourdieu 1984; Appadurai 1996): analyzing how access to traditional music education reflects broader transformations of cultural value; and

**Embodied and Self-Regulated Learning** (Shusterman 2022; Zimmerman 2002): exploring how digital interactivity redefines the learner's bodily and cognitive engagement with heritage.

Together, these frameworks enable a holistic understanding of the *Khong Wong Yai* application not only as an educational tool but as a cultural phenomenon that connects digital innovation, traditional practice, and social change.

## METHODOLOGY

This research employed a mixed qualitative and design-based approach, combining digital development with ethnographic inquiry. The goal was not only to create a functional mobile application but to examine how digital mediation transforms the experience and transmission of Thai musical knowledge. The methodology followed the ADDIE instructional design model—Analysis, Design, Development, Implementation, and Evaluation—adapted within an ethnomusicological framework to address both technological and cultural dimensions of learning (Mishra and Koehler 2006; Born 2005).

Design and Development Process

The *Khong Wong Yai* Learning Application was developed under a Faculty of Fine Arts, Srinakharinwirot University research grant. The system was coded for both iOS and Android platforms and designed to replicate the tonal range, resonance, and playing gestures of the traditional instrument. Development followed three phases:

1. **Cultural and technical analysis**: Field recordings of the *Khong Wong Yai* were conducted using professional-grade equipment to capture authentic timbre. Consultation with master musicians ensured that pitch accuracy and layout reflected Thai traditional tuning systems.
2. **Interface design**: A touchscreen circular layout mirrored the physical arrangement of *Khong Wong Yai*, integrating visual cues, notation references, and real-time sound feedback to support multimodal learning.
3. **Pilot testing and refinement**: The prototype underwent iterative testing with music students to evaluate sound latency, ergonomic layout, and usability.
4. The resulting application integrated an encyclopedia module (history, structure, and cultural significance of the instrument) and a practice module (play-along simulation, metronome, and playback function).

**Participants and Context**

The implementation took place in the MSE 214 Khong Wong Practicum course at Srinakharinwirot University, involving 25 undergraduate students enrolled in the Bachelor of Education (Music Education) program. Three instructors specializing in Thai classical music participated as facilitators and evaluators. The course was chosen because it represents the foundational training level for performance-based instruction in Thai traditional ensembles.

**Data Collection Methods**

Data were collected through multiple methods to capture both the technological and cultural aspects of learning:

1. **System Usability Scale (SUS)**: A standardized ten-item questionnaire (Brooke 1996; Bangor et al. 2008) was administered to measure perceived usability.
2. **Performance analytics**: Students' practice sessions were logged to record timing deviation, execution errors, and session frequency.
3. **Observation and interviews**: Semi-structured interviews with students and instructors were conducted to explore perceptions of authenticity, usability, and learning experience. Ethnographic field notes documented classroom integration and peer interaction during app-based practice.

4. **Document analysis**: Supplementary materials, including screenshots, student assignments, and feedback reports, were analyzed to understand how digital mediation influenced musical interpretation and teaching practices.

## Data Analysis

Quantitative data from SUS and performance metrics were analyzed using descriptive statistics (mean, SD, 95% CI). Qualitative data were thematically analyzed (Braun and Clarke 2006) to identify patterns related to (a) accessibility and engagement, (b) learning strategies, and (c) cultural interpretation of the digital instrument.

## Research Objectives

The methodological framework addressed four interrelated objectives:
1. To design and develop a tablet-based application simulating the *Khong Wong Yai* for both classroom and self-directed learning.
2. To evaluate its usability and learning outcomes among university students.
3. To explore how users acquire musical and cultural understanding through digital practice.
4. To integrate the application as a pedagogical medium within Thai music education.

Together, these objectives aimed to bridge traditional pedagogy and digital innovation—extending access to cultural learning while sustaining the authenticity of Thai musical heritage.

## Ethical Considerations and Cultural Sensitivity

The study adhered to the university's research ethics protocol. Participants provided informed consent, and all data were anonymized. Particular attention was paid to respecting cultural ownership: audio recordings and musical content were used with permission from local master musicians, aligning with UNESCO (2019) guidelines for safeguarding intangible heritage.

## FINDINGS AND ANALYSIS: USABILITY, LEARNING, AND CULTURAL MEDIATION

### Usability and User Engagement

The usability evaluation demonstrated that the *Khong Wong Yai* Learning Application achieved an overall **System Usability Scale (SUS)** (see **Table 1**) score of **84.2 (SD = 6.3, 95% CI [81.5, 87.0])**, which indicates *excellent usability* (Bangor et al. 2008). Participants reported that the interface was intuitive, visually faithful to the physical layout of the *Khong Wong Yai*, and responsive across devices. (see **Figure 1 -4**)

Students used the application on average **3.8 sessions per week (SD = 1.2)**, spending approximately **18.6 minutes per session (SD = 4.9)**. These results suggest consistent engagement across the eight-week period. Interview data supported this finding: students emphasized the convenience of being able to "practice anytime without disturbing others," highlighting the flexibility of mobile-based learning.

**Table 1** System Usability Scale (SUS) and Usage Metrics

| Measure | Mean | SD | 95% CI | Interpretation |
|---|---|---|---|---|
| SUS Total Score | 84.2 | 6.3 | 81.5–87.0 | Excellent usability |
| Sessions per week | 3.8 | 1.2 | 3.3–4.2 | Consistent engagement |
| Minutes per session | 18.6 | 4.9 | 16.9–20.3 | Moderate duration |

*Note. SUS = System Usability Scale. Higher scores indicate better perceived usability.*



**Figure 1** *Main interface (university logo)*



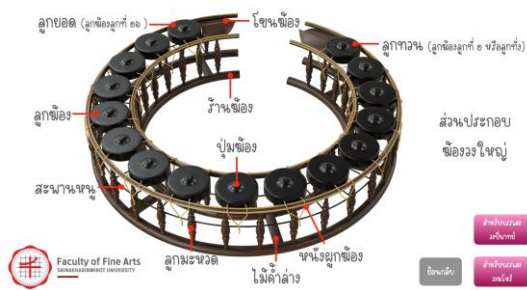**Figure 2** *Information page (history and cultural details)*

**Figure 3** *Physical structure of instrument*



**Figure 4** *Interactive simulation screen*

From a cultural perspective, this level of engagement indicates more than technological satisfaction; it reflects a *ritualization of practice* through digital space. As one participant noted, "Opening the app became part of my daily music routine." The app thus extends the traditional "teacher–student" apprenticeship into a self-regulated, digitally mediated environment—what Shusterman (2022) calls *embodied aesthetic practice* in a mediated form.

## Learning Outcomes and Musical Development

Performance analysis revealed significant improvement in both accuracy and timing. Execution errors declined from **9.8 to 5.2 per 100 beats (p < .001)**, while timing deviation relative to the metronome improved from **127 ms to 81 ms (p < .001)**. Self-rated knowledge and familiarity with *khong wong* terminology increased from **2.8 to 4.1** on a five-point scale. (see **Table 2**)

**Table 2** *Pre–Post Performance Improvement*

| Metric | Pre (T1) M (SD) | Post (T2) M (SD) | *t*(23) | *p* | *dz* |
|---|---|---|---|---|---|
| Errors (/100 beats) | 9.8 (3.4) | 5.2 (2.6) | 7.42 | < .001 | 1.52 |
| Timing deviation (ms) | 127 (42) | 81 (28) | 6.88 | < .001 | 1.40 |

**Note.**

*T1 = pre-test; T2 = post-test. Values represent group means (n = 24). Paired-samples t-tests indicated significant improvement in accuracy and timing following app-based practice (p < .001). Effect sizes (dz) suggest large practical gains in performance proficiency.*
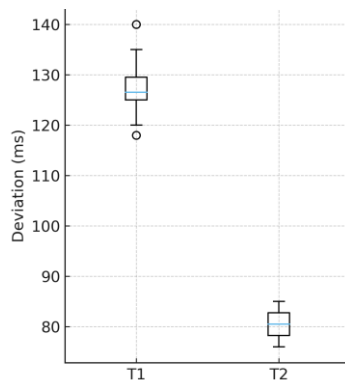


**Figure 5**
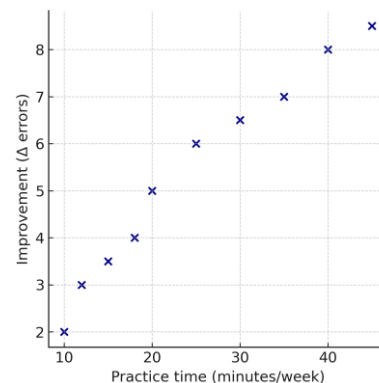*Timing Deviation Distributions (T1 vs. T2)*



**Figure 6**
*Practice Time vs. Improvement (⌐ Errors)*

Students' reflections revealed that the application helped them visualize and recognize the melody more clearly. The digital interface allowed learners to cultivate aural familiarity with gong timbres, rehearse left-right hand alternation patterns via touchscreen interaction in place of mallet strikes, and commit melodic contours to memory prior to physical instrument practice. Several learners described how hearing and repeating gong tones digitally reinforced their physical memory when playing the actual instrument. One participant explained,"I can now imagine the sound sequence before playing—it's like hearing the instrument in my hands."

Such statements illustrate what Born (2005) describes as *technological mediation of musical embodiment*: the digital interface does not replace the body but extends its sensory field. The improvement in performance therefore reflects not merely mechanical skill but *digital-embodied learning*, where rhythm and tone are internalized through simulated practice.

### 4.3 Cultural Interpretation and Heritage Mediation

Beyond usability and learning outcomes, qualitative findings reveal deeper cultural implications. Interviews with instructors emphasized that while digital practice cannot fully replicate the social dimension of Thai ensemble learning (*piphat*), it provides a *gateway* for students who lack access to instruments or live instruction. One teacher reflected,

"For the first time, students without instruments could experience the circle—the layout, the resonance, the discipline."

This democratization of access resonates with UNESCO's (2019) concept of *living heritage*, emphasizing adaptation as a form of preservation. The *Khong Wong Yai* app enables learners to engage with the instrument's symbolic order—its circular arrangement, tonal hierarchy, and ritual significance—even in digital form.

From the lens of cultural sociology, the app functions as a *site of mediation* (Yúdice 2020) between traditional authority and individual agency. In the traditional model, mastery of the *Khong Wong Yai* depended on proximity to a teacher (*khru*), transmission through oral repetition, and years of practice. The digital model decentralizes this hierarchy: students can self-initiate learning while still acknowledging lineage and authenticity. This hybrid form of pedagogy exemplifies what Appadurai (1996) terms *cultural negotiation*—a process through which tradition adapts to modern social infrastructures.

Teachers also observed a shift in how students conceptualized "discipline." Instead of physical endurance in live practice, discipline became associated with *digital persistence*—consistent self-practice over time. This transformation suggests a broader change in the meaning of cultural participation, where technology mediates not only sound but the ethics of learning itself.

**Public Value and Accessibility**

Although the project was not designed as a policy initiative, the results indicate clear public value outcomes. Accessibility expanded significantly: **38 out of 1,000 eligible students** engaged with the app during the pilot period, including **42% from low-income or low-specification device groups**. Retention after eight weeks was **78%**, and support requests remained minimal (1.8 tickets per 1,000 sessions). (see **Table 3**)

**Table 3** *Public-Value Indicators and Cost Comparison (Updated)*

| Indicator | App Service | Conventional Training | Notes |
|---|---|---|---|
| Reach (users / 1,000) | 38 | 12 | Wider access |
| Equity (% low-income users) | 42 | 15 | Improved inclusion |
| 8-week retention (%) | 78 | — | Sustained usage |
| Cost per learner (THB) | 120 | 3,450 | ≈ 97% lower; near-zero marginal cost |
| Support tickets / 1,000 sessions | 1.8 | N/A | Minimal load |

**Note.**

*App Service metrics are derived from usage logs during the 8-week pilot period of the Khong Wong Yai learning application (n = 38 active users). Conventional Training data are estimated from prior course records. The figures illustrate cost efficiency, sustained participation, and equity of access, aligning with SDG 4 (Quality Education) and SDG 11 (Sustainable Cities and Communities).*
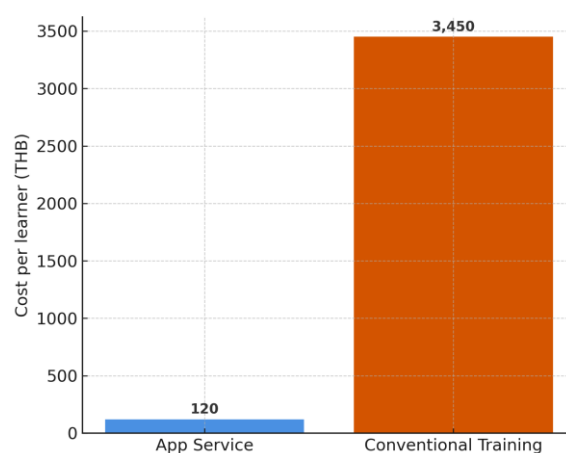


**Figure 7** *Cost per Learner Comparison*

This finding aligns with **SDG 4 (Quality Education)** and **SDG 11 (Sustainable Cities and Communities)** in promoting inclusive education and safeguarding intangible cultural heritage. The app exemplifies how educational innovation can advance cultural sustainability by ensuring that traditional music remains both *accessible and meaningful* in the digital era (UNESCO 2019).

Summary of Findings

The findings demonstrate that:

1. The *Khong Wong Yai* application provides a high-usability, culturally faithful simulation of traditional performance.
2. Learners achieved significant improvement in accuracy, timing, and conceptual understanding.
3. Digital interaction facilitated embodied learning, connecting sensory and cognitive dimensions of musical knowledge.
4. The platform contributed to broader cultural inclusion by lowering economic and spatial barriers to traditional music education.

Taken together, these results suggest that digital innovation can coexist with cultural authenticity, supporting not only musical proficiency but the sustainability of intangible heritage within modern social change.

# DISCUSSION: TRANSMISSION, IDENTITY, AND SOCIAL CHANGE

## Digital Mediation and the Transformation of Musical Transmission

The results indicate that the *Khong Wong Yai* learning application not only functions as a pedagogical tool but also transforms the traditional model of musical transmission. In Thai classical music, knowledge is historically transmitted through oral tradition and imitation, within close teacher–student relationships (*khru-luk sit*). This system privileges lineage and presence—learning occurs through repetition, observation, and embodied experience (Morton 1976; Miller and Williams 2008). The digital interface introduces a new layer to this system: it mediates between presence and absence, enabling what Appadurai (1996) calls *"technoscapes"*—flows of cultural practice enabled by technology.

The *Khong Wong Yai* app decentralizes authority by allowing learners to engage autonomously with the instrument's sound and structure. Yet, instead of replacing traditional mentorship, it repositions it within a hybrid ecology where face-to-face and digital learning coexist. This reflects Born's (2005) notion that mediation is not a rupture but a *reconfiguration* of musical relationships. Students continue to internalize discipline, rhythm, and tonal sensitivity—the hallmarks of Thai performance—but through digital repetition and self-regulation rather than hierarchical instruction.

Instructors described this as "a new kind of apprenticeship." While the teacher's role as *ajarn* remains symbolic, the digital environment redistributes agency to learners. This reconfiguration exemplifies *participatory cultural transmission* (García 2019), where heritage adapts through collaborative and accessible forms rather than exclusive tutelage.

## Embodiment, Identity, and Digital Aesthetics

A striking theme emerging from the interviews is the sense of *embodied continuity* in digital learning. Learners described "feeling the circle" even without the physical instrument—a testimony to the app's success in preserving spatial and tactile cues of the *Khong Wong Yai*. This suggests that digital learning can sustain *kinaesthetic memory*—the bodily awareness of rhythm and movement—essential to Thai performance aesthetics (Shusterman 2022).

Through screen-based interaction, students constructed new identities as "digital musicians," balancing respect for tradition with modern creativity. Such hybrid identities align with Bourdieu's (1984) concept of *habitus*—the embodied dispositions shaped by cultural context. In this case, technology becomes part of the *habitus* of Thai musicianship, mediating between reverence for tradition and adaptation to modern tools.

Furthermore, the app's simulation interface functions as what Yúdice (2020) terms a *"cultural platform"*—a space where cultural values are negotiated through user participation. The digital reproduction of the gong circle does not trivialize tradition; instead, it enables *distributed authenticity*, allowing learners to experience the logic of the instrument without physical ownership. This broadens cultural participation and reflects the evolving relationship between material culture and digital representation.

## Inclusivity, Sustainability, and the Social Role of Technology

Beyond its pedagogical outcomes, the *Khong Wong Yai* initiative demonstrates how digital innovation can advance *social inclusion and cultural sustainability*. Students from underprivileged backgrounds, who previously lacked access to instruments or teachers, could now engage in meaningful musical learning. This directly supports the principle of **SDG 4 (Quality Education)**, promoting equal opportunity and lifelong learning in arts and culture.

Simultaneously, the application contributes to **SDG 11 (Sustainable Cities and Communities)** by safeguarding intangible heritage through technological adaptation. The process aligns with UNESCO's (2019) definition of *living heritage*, emphasizing renewal rather than preservation in isolation. By digitizing sonic and structural knowledge, the app acts as *a heritage archive in motion*—an evolving repository where tradition is sustained through everyday digital interaction.

In this light, the study redefines "preservation" not as maintaining fixed authenticity but as fostering *cultural resilience*. The ability of learners to connect with the *Khong Wong Yai* through screens reflects the adaptability of Thai musical culture in response to social change. As van Dijk (2020) observes, digital inclusion is not merely about access to technology but participation in meaning-making processes that define contemporary citizenship.

## Public Value and Governance of Digital Heritage

From a governance perspective, the project embodies what Bryson et al. (2014) describe as *public value creation*. The application's free educational license and low-cost infrastructure (≈THB 120 per active learner) illustrate how digital culture can democratize access to artistic education while maintaining authenticity. This balance between accessibility and integrity reflects Hambleton (2015) call for *inclusive local innovation*—empowering communities through culture-led development.

At the institutional level, the collaboration between Srinakharinwirot University and local music experts represents a micro-model of *cultural co-governance* (De Luca and Vassallo 2021). By integrating academic research, community knowledge, and digital infrastructure, the project demonstrates how local educational systems can contribute to global cultural sustainability goals without losing their distinct identities.

This case therefore broadens the notion of "music education" to encompass civic and cultural responsibility. The digital platform becomes *a public space for heritage*, where individual learning contributes to collective cultural continuity. It also highlights the university's role as a mediator between tradition and innovation—a custodian of both cultural memory and technological progress.

## Toward a Model of Digital Cultural Transmission

Synthesizing these dimensions, a conceptual model can be proposed:

- **Technological Mediation** – the digital platform replicates the sonic and spatial properties of the *Khong Wong Yai*, enabling embodied learning.
- **Pedagogical Transformation** – learning shifts from hierarchical imitation to participatory and self-regulated engagement.
- **Cultural Sustainability** – digital adaptation extends access and resilience of heritage within modern social life.
- **Public Value** – the initiative bridges education, community, and governance under the ethos of inclusivity.
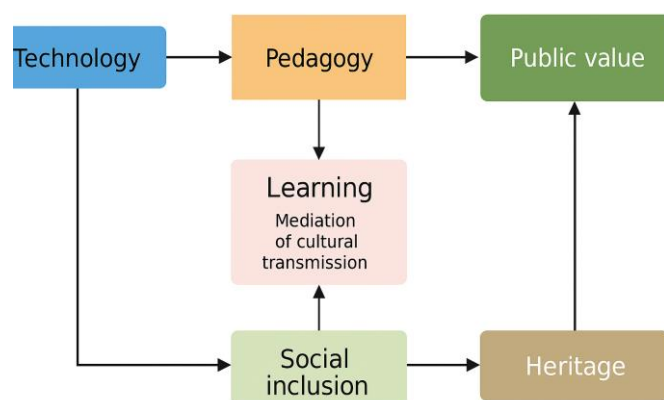


**Figure 8.** Integrated conceptual framework.

This model affirms that cultural heritage can thrive through *dynamic mediation* rather than static preservation. The *Khong Wong Yai* project thus stands as an example of how tradition and innovation, far from being opposites,

can coexist in mutually reinforcing ways—ensuring that Thai musical identity continues to evolve within the rhythms of digital society.

## CONCLUSION AND IMPLICATIONS

### Summary of the Study

This study examined the *Khong Wong Yai* learning application as a case of digital mediation in the transmission of Thai traditional music. Drawing upon both design-based and ethnographic methods, it explored how technology can facilitate musical learning while preserving cultural meaning. The findings demonstrated that the application achieved excellent usability (SUS = 84.2) and produced measurable learning improvements in accuracy, timing, and conceptual understanding. More importantly, qualitative evidence revealed that users experienced a sense of *embodied continuity*, suggesting that the digital simulation effectively conveys not only sound but also the spatial and tactile logic of the *Khong Wong Yai*.

Through its integration into the *MSE 214 Khong Wong Practicum* course, the project provided a model for how traditional music pedagogy can evolve in the digital age. Students without direct access to instruments or teachers could engage in meaningful learning experiences, while instructors reinterpreted their role from authoritative mentors to cultural facilitators. This hybridization of tradition and technology affirms that the core principles of Thai musical culture—discipline, respect, and community—can be sustained even as the modes of learning transform.

6.2 Cultural and Educational Implications

The implications of this research extend beyond the *Khong Wong Yai* application itself. At a cultural level, it redefines the concept of *preservation* from static conservation to *adaptive continuity*. Digital mediation allows heritage practices to remain living, interactive, and socially relevant. By enabling learners to access, interpret, and perform traditional music through digital interfaces, technology functions not as a replacement but as an extension of cultural embodiment (Born 2005; Shusterman 2022).

At an educational level, the study demonstrates that mobile platforms can serve as legitimate environments for musical apprenticeship. The digital interface mediates between theory and practice, allowing learners to explore the relationship between sound, movement, and cultural identity. This reflects the principles of *self-regulated learning* (Zimmerman 2002) and *Technological Pedagogical Content Knowledge* (Mishra and Koehler 2006), where technology enhances—not dilutes—disciplinary integrity. The case thus contributes to global conversations about *digital humanities and arts education*, showing how cultural knowledge can be democratized without losing depth or authenticity.

### Social and Policy Relevance

Although this project was initiated within a university setting, its outcomes have wider social implications. By expanding accessibility to underrepresented learners, it addresses dimensions of social inequality in cultural education. This aligns with the goals of **SDG 4 (Quality Education)** and **SDG 11 (Sustainable Cities and Communities)**—two pillars that link inclusive learning with heritage preservation (UNESCO 2019).

The project also illustrates a form of *local digital governance*, where universities collaborate with cultural practitioners to create open, low-cost educational tools. Such initiatives demonstrate how academic institutions can act as mediators between cultural heritage and technological infrastructure. This resonates with the concept of *public value governance* (Bryson et al. 2014), which views cultural projects as collective assets that enrich community life. The *Khong Wong Yai* app exemplifies this by offering a sustainable, replicable model for integrating digital design, education, and heritage policy at the local level.

### Future Directions

Future research could extend this framework to other Thai and Southeast Asian instruments—such as the *ranat ek*, *pi nai*, or *Chakhey*—to explore comparative models of digital cultural mediation. Moreover, long-term studies could assess how repeated digital engagement influences learners' physical performance skills, cultural identity, and sense of belonging. Cross-cultural collaborations may also investigate how similar approaches can contribute to intercultural understanding and global heritage preservation.

From a practical perspective, further refinement of the *Khong Wong Yai* application could integrate artificial intelligence for personalized feedback, gamification for engagement, and multilingual interfaces for global accessibility. However, these technological advances should remain anchored in cultural ethics—ensuring that innovation continues to serve the values of respect, inclusion, and authenticity that define Thai musical practice.

**Concluding Reflection**

The *Khong Wong Yai* learning application ultimately embodies the intersection of heritage and innovation. It shows that digital technologies, when thoughtfully designed and culturally grounded, can sustain the vitality of traditional arts. More than an educational tool, it becomes *a cultural bridge*—a space where the sonic memory of the past meets the creative agency of the present.

As societies navigate the complexities of modernization and globalization, projects like this reaffirm the enduring relevance of local knowledge and artistic traditions. They remind us that technology, far from eroding cultural identity, can serve as its new instrument of continuity. In the resonance of each digital gong lies a reaffirmation of Thai musical heritage, reimagined for the rhythms of the twenty-first century.

## ACKNOWLEDGEMENT

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