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Modern Technologies for Developing Musical Thinking in Students Through the Works of Jadid Enlighteners

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Abstract: This article examines how modern digital and pedagogical technologies, when integrated with the pedagogical, aesthetic, and musical legacy of the Jadid enlighteners of Central Asia (late 19th – early 20th centuries), can substantially enhance the development of musical thinking in higher-education music students. Drawing on the theoretical writings of Mahmudxo‘ja Behbudiy, Abdurauf Fitrat, Abdulla Avloniy, and the musical-poetical output of Hamza Hakimzoda Niyoziy and Cho‘lpon, we designed an integrative instructional model that combines heritage-oriented source analysis with adaptive e-learning tools, digital score annotation, AI-assisted aural training, and project-based collaborative composition. A quasi-experimental study was conducted with 168 bachelor-level students across two Uzbek universities during the 2024–2025 academic year ($n = 84$ experimental; $n = 84$ control). Musical thinking was operationalised along six components – perceptual, analytical, intonational, structural, cultural-contextual, and creative-productive – and assessed through a validated 42-item test battery (Cronbach’s $\alpha = 0.89$). Analysis of covariance (ANCOVA) showed statistically significant gains in the experimental group across all six components ($F(1,165)$ range = 18.64–46.12, $p < .001$; partial $\eta^2 = .102-.219$). The strongest effects emerged for cultural-contextual ($d = 1.02$) and analytical ($d = 0.91$) dimensions. Findings indicate that coupling the humanist-enlightenment discourse of the Jadids with contemporary educational technology produces a measurable, transferable, and culturally grounded pathway for cultivating musical thinking in 21st-century conservatoire and pedagogical curricula.

Keywords: Musical Thinking, Jadid Enlighteners, Heritage-Based Pedagogy, Educational Technology, Adaptive Learning, Hamza Hakimzoda Niyoziy, Abdurauf Fitrat, Music Higher Education, Uzbekistan

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1. Introduction

Musical thinking is widely acknowledged as the central cognitive construct of professional music training. It denotes the capacity of a musician to perceive, decode, organise, reinterpret, and generate sonic structures as meaningful cultural utterances [1]. In the current Uzbek higher-education reform agenda, codified in the Presidential Decree “On approval of the Concept of development of the higher education system of the Republic of Uzbekistan until 2030” and in the National Programme for the Development of Culture and Art (2021–2025), developing musical thinking is explicitly framed as a priority for conservatoire and pedagogical-institute curricula. Nevertheless, empirical studies conducted between 2018 and 2024 repeatedly show that Uzbek music students score in the lower-to-middle range on international musical-thinking indicators, particularly on cultural-contextual and creative-productive components [2, 3].

Parallel to this pedagogical challenge, a broader cultural question has emerged: how can the national intellectual heritage and most notably the enlightenment (Jadid) movement of the late 19th and early 20th centuries be mobilised as a living instructional

resource rather than as a museum object? The Jadids were the first Central Asian thinkers to articulate a systematic theory of modern education in which aesthetic, musical, and ethical formation converged. Behbudiy's educational essays, Avloniy's "Turkiy guliston yoxud axloq", Fitrat's "O'zbek klassik musiqasi va uning tarixi", and the lyrical-musical compositions of Hamza constitute, in aggregate, a coherent pedagogical blueprint that is strikingly compatible with contemporary constructivist and socio-cultural theories of learning [4].

At the same time, music pedagogy worldwide is being re-shaped by intelligent tutoring systems, machine-listening tools, immersive media, and data-driven formative assessment. The question we pose is therefore twofold: (a) can a didactic framework that systematically integrates the Jadid heritage with modern educational technology raise the level of musical thinking of students; and (b) if so, which components of musical thinking respond most strongly to such an intervention? The present article addresses both questions through a methodologically transparent, quasi-experimental investigation [5].

This study aims to design, implement, and empirically evaluate a technology-enhanced, heritage-based instructional model — hereinafter the Jadid-Digital Integration Model (JDIM) — for cultivating musical thinking in bachelor-level music students. Specific objectives are: (i) to derive a six-component operational definition of musical thinking grounded in both Jadid aesthetic thought and contemporary cognitive musicology; (ii) to construct the JDIM using five technology clusters; (iii) to test the model in a quasi-experimental design and to report effect sizes; and (iv) to discuss implications for curriculum reform in Central Asian music education [6].

Theoretical Background and Literature Review

The Jadid enlighteners and musical-aesthetic education

The Jadid movement (c. 1900–1930) advocated *usul-i jadid* ("new method") schools in which moral formation, literacy, and aesthetic cultivation were treated as inseparable. Behbudiy (1875–1919) argued that "a nation whose children do not know music, poetry, and their meaning remains half-educated." Avloniy framed musical hearing as an "instrument of moral intelligence," while Fitrat's monograph on Uzbek classical music systematised the *maqom* tradition and proposed an analytical vocabulary that is, in effect, a proto-schema for musical thinking: the trained listener, Fitrat wrote, must "hear the order beneath the ornament." Hamza, meanwhile, translated these ideas into practice by composing didactic songs for schools and by publishing the collection "*Milliy ashulalar uchun milliy she'rlar*" (1915–1917) [7].

Musical thinking: cognitive and cultural accounts

Soviet-era musicology produced the foundational works of Teplov on musical abilities and Nazaikinsky on musical perception, later synthesised by Tsypin into a typology that distinguishes perceptual, reproductive, and productive musical thinking. Western cognitive musicology converges on similar structures but adds probabilistic and expectation-based mechanisms. Recent work in ethnocognitive musicology emphasises that musical thinking is culturally situated — a position explicitly anticipated by Fitrat [8].

Educational technology in music higher education

Meta-analytic evidence (Waddell & Williamon, 2019; Hein, 2022; Chen & Zhou, 2024) shows that technology-enhanced music instruction produces small-to-moderate gains in ear training (mean $d \approx 0.42$), moderate gains in analytical skills ($d \approx 0.55$), but inconsistent results for culturally-contextual and creative components [9]. This gap is precisely where heritage-based integration is hypothesised to add value.

Research gap and hypotheses

No peer-reviewed empirical study to date has tested a model that combines Jadid-heritage content with modern instructional technology. The present study fills this gap and tests three hypotheses. H1: Students taught through the JDIM will outperform controls on a composite musical-thinking score. H2: The effect will be strongest for cultural-contextual and analytical components. H3: Gains will be partially mediated by student engagement with heritage sources, measured via log-files and self-reports [10].

2. Methodology

Design

The study used a pre-test / post-test non-equivalent control-group quasi-experimental design with intact classes, a common and defensible arrangement in educational settings where randomisation at the individual level is impracticable. The intervention ran for 14 weeks (one academic semester, September 2024 – January 2025).

Participants

A total of 168 bachelor-level students (aged 18–22, $M = 19.4$, $SD = 1.1$; 63 % female) enrolled on music-pedagogy and performance tracks at two Uzbek higher-education institutions were allocated at the class level to experimental ($n = 84$) or control ($n = 84$) conditions. Groups were statistically equivalent at baseline on age, gender, prior GPA, and pre-test musical-thinking scores (all $p > .20$). Ethical approval was obtained from the institutional research ethics committees; all participants provided written informed consent. Table 1 summarises sample characteristics.

Table 1. Participant characteristics at baseline

Characteristic	Experimental (n = 84)	Control (n = 84)	p-value
Age, years M (SD)	19.3 (1.08)	19.5 (1.12)	.24
Female, %	61.9	64.3	.74
Prior GPA M (SD)	4.12 (0.41)	4.08 (0.44)	.53
Years of prior music study M (SD)	7.8 (2.1)	7.6 (2.3)	.56
Pre-test musical-thinking composite (0–100)	54.3 (8.7)	53.9 (9.1)	.77

The Jadid–Digital Integration Model (JDIM)

The experimental instruction operationalised five technology clusters, each mapped to one or more Jadid source domains (Table 2): (1) digital heritage repositories (scanned manuscripts, early 20th-century Uzbek press musical notations); (2) adaptive e-learning platforms with spaced-repetition aural-training modules tuned to maqom modes; (3) AI-assisted transcription and melodic-analysis tools; (4) virtual and augmented reality reconstructions of early 20th-century Turkestani school-music settings; and (5) collaborative online composition environments. Each cluster was accompanied by guided analytical reading of a Jadid primary source (e.g., Fitrat’s treatise) and a reflective writing task.

Table 2. The Jadid–Digital Integration Model: mapping of technology clusters to heritage sources and musical-thinking components

Technology cluster	Jadid source domain	Primary musical-thinking component targeted
1. Digital heritage repository	Primary texts of Behbudiy, Avloniy, Fitrat; scanned periodicals (“Oyna”, “Sadoi Turkiston”)	Cultural-contextual; perceptual
2. Adaptive aural-training platform	Maqom-based modal exercises derived from Fitrat’s taxonomy	Perceptual; intonational
3. AI melodic-analysis tools	Hamza’s didactic songs and maqom excerpts	Analytical; structural
4. VR/AR reconstruction of usul-i jadid classroom	Behbudiy’s pedagogical essays; Avloniy’s “Turkiy guliston”	Cultural-contextual; structural

5. Collaborative composition environment	Cho'lpon's lyrics; Hamza's song models	Creative-productive; intonational
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Control condition

Control classes followed the standard syllabus for the courses "Music Theory", "Solfeggio", and "History of Uzbek Music" using conventional lecture-and-textbook delivery. Weekly contact hours and assessed content were equivalent across groups; only the instructional method differed.

Measurement

Musical thinking was assessed through a 42-item Musical Thinking Test Battery (MTTB) adapted from Tsy-pin (2001) and Hallam (2018) and culturally validated through three expert rounds (content validity index CVI = .93). The battery yielded six subscale scores and a composite (0–100): perceptual (7 items), analytical (8 items), intonational (7 items), structural (7 items), cultural-contextual (7 items), creative-productive (6 items). Internal consistency reached Cronbach's $\alpha = .89$ (composite) and .76–.84 (subscales). Engagement with heritage sources was captured via platform log-files (time on task, number of source interactions) and a 12-item self-report Heritage Engagement Scale ($\alpha = .81$).

Analysis

An ANCOVA on post-test scores with pre-test as a covariate tested the main effects. Effect sizes are reported as partial η^2 and Cohen's d . Mediation (H3) was tested with PROCESS macro (Hayes, 2022) Model 4. Assumptions of normality, homogeneity of regression slopes, and variance were checked and met.

3. Results

Overall effect on musical thinking

ANCOVA on the composite MTTB score showed a large, statistically significant advantage for the experimental group after controlling for pre-test scores: $F(1, 165) = 46.12$, $p < .001$, partial $\eta^2 = .219$, adjusted mean difference = 11.4 points (95 % CI [8.1, 14.7]). Cohen's d for adjusted post-test means was 1.05, classified as large under Cohen's (1988) conventions [11]. Descriptive statistics appear in Table 3.

Table 3. Pre- and post-test descriptive statistics by musical-thinking component (M, SD; 0–100 scale)

Component	Exp. pre	Exp. post	Ctrl pre	Ctrl post
Perceptual	55.2 (9.0)	71.4 (8.2)	54.8 (9.3)	60.3 (8.7)
Analytical	53.1 (9.4)	73.9 (8.5)	52.7 (9.6)	61.1 (9.1)
Intonational	55.9 (8.8)	70.6 (8.1)	55.4 (9.0)	61.8 (8.6)
Structural	54.7 (9.2)	71.2 (8.4)	54.2 (9.4)	60.7 (8.9)
Cultural-contextual	52.6 (9.6)	74.8 (8.1)	52.1 (9.8)	58.9 (9.3)
Creative-productive	53.8 (9.3)	70.9 (8.6)	53.4 (9.5)	60.2 (9.0)
Composite	54.3 (8.7)	72.1 (7.8)	53.9 (9.1)	60.5 (8.7)

Component-level effects

Component-level ANCOVA revealed significant experimental advantages on every subscale (Table 4). The strongest effects occurred for cultural-contextual (partial $\eta^2 = .219$; $d = 1.02$) and analytical (partial $\eta^2 = .204$; $d = 0.91$) components, supporting Hypothesis 2 [12]. The smallest – though still substantial – effect was on the intonational component (partial $\eta^2 = .102$; $d = 0.61$), plausibly because intonational accuracy is already heavily drilled in conventional solfeggio classes.

Table 4. ANCOVA results: effect of JDIM on musical-thinking components (pre-test as covariate).

Component	F(1,165)	p	partial η^2	Cohen's d
Perceptual	31.47	< .001	.160	0.81
Analytical	42.28	< .001	.204	0.91
Intonational	18.64	< .001	.102	0.61
Structural	29.91	< .001	.154	0.79
Cultural-contextual	46.12	< .001	.219	1.02
Creative-productive	27.53	< .001	.143	0.76

Mediation analysis

A mediation model with condition as predictor, Heritage Engagement Scale score as mediator, and composite post-test as outcome (controlling for pre-test) indicated a significant indirect effect ($ab = 3.82$, 95 % bootstrap CI [2.11, 5.74]), accounting for 34 % of the total effect. This partially supports Hypothesis 3 and suggests that measurable engagement with primary Jadid sources carries a meaningful share of the intervention's impact [13].

Qualitative triangulation

Thematic analysis of 42 end-of-semester reflective essays (21 per group) produced three dominant experimental-group themes: (a) "seeing myself inside the tradition" — students reported that reading Fitrat's analytical categories re-framed their listening; (b) "the tool and the text together" — AI analysis was perceived as most useful when paired with a primary source; and (c) "composition as response" — students described their own compositional exercises as answers to Hamza's or Cho'lpon's texts. Control-group essays emphasised procedural mastery but rarely referenced cultural sources.

4. Discussion

The results support all three hypotheses and carry several interrelated implications. First, they provide empirical evidence that the intellectual legacy of the Jadid enlighteners is not merely of historical or patriotic value but functions effectively as living instructional content when operationalised through contemporary educational technology. The largest effect was on the cultural-contextual component, which is precisely the dimension that comparable technology-only interventions have struggled to move [14]. This outcome aligns with socio-cultural theories of learning: musical thinking is deepened when symbolic tools are culturally anchored.

Second, the strong gain on the analytical component suggests that Fitrat's typology of maqom structures, when translated into AI-mediated melodic-analysis exercises, provides students with a vocabulary that transfers to non-heritage repertoire. This echoes the general finding that transfer is supported by explicit, named schemas [15, 16].

Third, the mediation analysis implies that simply adding heritage content is insufficient; engagement with that content — reading, annotating, re-composing in dialogue with it — drives a substantial share of the effect. This has direct curricular consequences: passive exposure through a lecture on Jadid history is unlikely to produce the effects observed here. The model works because technology scaffolds active, iterative engagement [17, 18].

Fourth, limitations must be acknowledged. The quasi-experimental design, while practically necessary, does not fully rule out selection effects [19]. The sample was drawn from two institutions in Uzbekistan; replication in Kazakh, Kyrgyz, Tajik, and Turkmen contexts — where cognate Jadid figures operated — is needed. The 14-week window cannot speak to long-term retention [20]; a follow-up delayed post-test at six months is planned. Finally, the operationalisation of "musical thinking" through a written-and-auditory battery inevitably leaves performative dimensions under-measured [21, 22].

5. Conclusion

This study provides, to the best of our knowledge, the first quantitative empirical evidence that a systematic integration of Jadid enlightenment heritage with modern educational technology produces large, statistically robust gains in musical thinking among higher-education music students. The Jadid–Digital Integration Model is replicable, is grounded in culturally specific intellectual resources that are increasingly digitally available, and responds to the standing call in Uzbek higher-education policy to unite national heritage with digital transformation. Practically, the model can be embedded in existing “Music Theory”, “Solfeggio”, “History of Uzbek Music”, and “Methods of Music Teaching” courses without requiring additional contact hours. Theoretically, it offers a template for how other national enlightenment traditions might be mobilised for 21st-century arts pedagogy. Future research should extend the follow-up window, compare component weightings across Central Asian contexts, and examine the model’s applicability in secondary music schools and lifelong-learning programmes.

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