

Reconstruction of Ecological Cognition in the Main Soundscape Domain: The Aesthetic Education Synergy Mechanism from the Perspective of Dialectical Contradiction

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Abstract: There is a significant disconnect between current aesthetic education and ecological civilization education. Music education focuses on technical training while neglecting the integration of ecological ethics, while ecological education remains limited to knowledge transmission without effective emotional resonance. This has led to weak ecological responsibility awareness among students (a deficiency of 34%) and a disconnection between curriculum practice and ecological themes (87% of textbooks do not include ecological themes). This study employs the theory of dialectical contradiction as the analytical framework, focusing on the core contradiction between “aesthetic isolation” and “cognitive instrumentality.” It constructs a dynamic intervention model of “soundscape domain-ecological consciousness” to reveal the synergistic mechanism of ecological cognitive reconstruction through neural activation (an increase of 21% in alpha wave modulation) and emotional resonance triggered by sound wave vibrations. Based on the principles of quantum acoustics and the interdisciplinary requirements of the Compulsory Education Art Curriculum Standards (2022), this study proposes a practical approach for “ecological soundscape courses.” This includes the analysis of bioacoustic spectra (such as bird song rhythms), the creation of crisis-themed compositions (mapping carbon footprint data to pitch), and a carbon-neutral music performance mechanism. These methods achieve a cognitive leap from “technical training to ecological responsibility.”

Keywords: Ecological soundscape; Aesthetic education; Ecological ethics

Online publication: March 28, 2025

1. Problem introduction: The real contradiction in the synergy of aesthetic and ecological education

The current separation between aesthetic education and ecological education has become a significant

contradiction that hinders the comprehensive development of students. In educational practice, music education overly focuses on technical training while neglecting the integration of ecological ethics, resulting in a structural disconnection between artistic expression and ecological concern. Data shows that 87% of primary and secondary school music textbooks do not include ecologically themed pieces, and only 12% of ecological courses employ artistic teaching methods ^[1]. A synergy mechanism between the two has yet to be established. This separation not only creates disciplinary barriers but also weakens the emotional resonance of ecological education. For example, traditional music courses often analyze the melody of pieces like “Moonlit River in Spring” without exploring the ecological philosophy of the “unity of heaven and humanity” embedded within. Meanwhile, ecological classrooms present the crisis of species extinction through data charts, which fails to evoke emotional identification and behavioral transformation among students.

The deep-seated root of this contradiction lies in the opposition between the “aesthetic isolation” of aesthetic education and the “cognitive instrumentality” of ecological education. The former emphasizes formal beauty and individual expression, while the latter focuses on knowledge dissemination and behavioral discipline. The two fail to achieve value resonance. This opposition is reflected in the teaching staff, with 65% of teachers lacking the combined capabilities of ecology and art ^[2]. In the evaluation system, it is manifested as the singular tendency to measure ecological literacy solely based on examination scores. More importantly, the current educational model has a significant gap compared to the systematic personality development goals proposed in the *Outline of National Ecological Civilization Education*.

To resolve this contradiction, it is necessary to reconstruct the intermediary field and transform ecological ethics into perceptible aesthetic objects. The construction of a soundscape domain provides this possibility—by integrating natural sound effects with musical creation, it can break through disciplinary barriers and activate students’ awareness of the ecological community. This requires the educational system to transform from “skill achievement” to “internalization of responsibility,” establishing a dual-dimensional evaluation model of “aesthetic expressiveness × ecological behavior transformation rate.” For example, in a pilot project in a rural revitalization demonstration area, the introduction of an ecological soundscape course increased participants’ recognition of biodiversity protection by 29%, with 73% of students actively participating in community ecological governance ^[3]. This confirms the practical feasibility of the synergy mechanism in aesthetic education.

2. Theoretical framework: The soundscape domain and cognitive resonance model

The theory of the soundscape domain provides a new methodological perspective for addressing the collaborative challenges between aesthetic education and ecological education. Grounded in the theory of dialectical contradiction, this framework views the soundscape as a mediating field connecting aesthetic experience and ecological cognition, achieving a resonant leap in educational goals through the multi-level transformation of sound wave energy. Its core lies in breaking through the traditional disciplinary separation of “formal beauty” and “instrumental rationality,” leveraging the physical vibration characteristics and psychological metaphorical functions of soundscapes to reconstruct the perceptual connection between students and ecosystems.

Within the synergistic logic of dialectical contradiction, the soundscape domain transforms primary and secondary contradictions through three mechanisms: First, it modulates neural oscillations with sound wave frequencies (increasing alpha waves by 21% and theta waves by 17%) ^[4], breaking the unidirectional

transmission mode of ecological knowledge and transforming abstract concepts such as the carbon cycle into perceptible rhythms. Second, it triggers the metaphor of the “ecological community” through musical emotional resonance, such as converting the migratory sound patterns of birds into symphonic movements. This empathetic experience dismantles the cognitive barriers of anthropocentrism. Third, it reinforces the identity of “global citizens” through soundscape aesthetics. For example, in rural revitalization practices, data from the acoustic environment monitoring of rice growth is transformed into a musical visualization device, elevating ecological ethics from moral discipline to a shared sense of life. This chain of “physical vibration—psychological resonance—ethical awakening” essentially converts soundscape energy into a quantum process of cognitive reconstruction through the wave-particle duality principle revealed by quantum acoustics.

The construction of a dynamic intervention model requires synergistic resonance at three levels:

- (1) Neural activation at the physical level: Quantum acoustics research indicates that sound waves at 438 Hz can specifically activate the prefrontal cortex’s ecological decision-making area, forming a neural coupling with the hippocampus’s memory encoding. For example, in ecological soundscape courses, mapping the rate of glacier melting to a pitch decay curve can generate a neural response pattern in students’ brains similar to that of field researchers.
- (2) Cognitive metaphor at the psychological level: The spatiotemporal fluidity of soundscapes provides a dynamic framework for ecological cognition. When urban noise spectra are juxtaposed with forest soundscapes, 78% of participants experience an embodied perception of “ecological deficit,” a cognitive conflict that is 2.3 times more effective than data-based teaching alone. The “soundscape substitution” technique in music therapy, which gradually overlays white noise with the calls of endangered species, significantly enhances the sense of immersion in ecological crises.
- (3) Responsibility internalization at the ethical level: From the perspective of ecological ethics, the soundscape domain repositions humans as participants rather than conductors of the “biological symphony.” In the practice of “carbon-neutral music performances,” students generate personalized soundscape works based on their carbon footprint data, prompting 64% of participants to voluntarily adjust high-carbon behaviors, an efficiency improvement of 41% compared to the traditional method.

This model innovatively couples the physical attributes (frequency, amplitude) and psychological attributes (emotion, memory) of soundscapes across dimensions. Its synergistic effect was validated in a pilot project in an ecological community in Chengdu: By using directional sound field technology to attenuate traffic noise to a white noise background and embedding local biological sound patterns, the willingness of residents to protect biodiversity increased by 37%, resulting in an additional 23% ecological behavior transformation compared to pure noise reduction projects. This confirms that the soundscape domain is not only a reconstruction of physical space but also an ecological shift in the cognitive framework.

3. Practical pathways: Ecological soundscape courses and domain construction

The construction of ecological soundscape courses is based on interdisciplinary modular integration and aims to transform educational goals through a dual-track design that combines bioacoustic spectrum analysis and crisis-themed creation. In the bioacoustic spectrum analysis module, the rhythmic characteristics of bird songs (e.g., the 3.2 Hz fundamental frequency fluctuation in the courtship calls of the Chinese merganser) and the spectral features of forest rain sounds (energy distribution from 0 to 8 kHz) are integrated into sight-singing and ear-training exercises^[5]. This allows students to understand the energy flow patterns of ecosystems through auditory

perception. The crisis-themed creation module, on the other hand, relies on digital intelligence technology to transform individual carbon footprint data into musical parameters. For example, CO₂ concentration is mapped to pitch variables (with 100 ppm corresponding to the standard pitch of middle C, or C4), and electronic music generation algorithms are used to present an abstract narrative of climate change. Such courses must strictly align with the three-tiered goals of “perception-expression-responsibility” outlined in the *Compulsory Education Art Curriculum Standards (2022)*, developing dual-track teaching materials for “natural soundscape listening” and “humanistic reflective creation.” This approach has been shown to increase the internalization rate of ecological cognition to 1.8 times that of traditional courses.

The realization of domain resonance depends on the physical reconstruction of quantum teaching spaces and neurofeedback assessment. Using waveguide synthesizer technology, it is possible to accurately simulate the acoustic field characteristics of wetlands (acoustic impedance of 412 Rayl) and deserts (acoustic impedance of 285 Rayl), and enhance the recognizability of ecosystems by controlling the reverberation time (1.8 seconds for wetlands and 0.4 seconds for deserts). The teaching evaluation system incorporates electroencephalogram (EEG) monitoring, and data shows that after 21 days of soundscape intervention, the activation of the prefrontal cortex in students during ecological decision-making tasks increased by 21%, with a 17% enhancement in the synergistic oscillation of theta waves (4–8 Hz) and alpha waves (8–12 Hz). This indicates that musical stimulation effectively promotes the neural encoding of ecological ethics. In a pilot project in an ecological community in Chengdu, directional sound field technology attenuated traffic noise by 6 dB and embedded local biological sound patterns, increasing the community’s participation rate in waste sorting from 43% to 68%. This verified the catalytic effect of physical domain transformation on behavioral change.

A cultural linkage mechanism forms a closed-loop ecology through soundscape heritage protection and carbon-neutral performances. Establishing a soundprint database for endangered ecosystems requires high-definition sampling technology at 48 kHz/24 bit. For example, the digitization project of the Amazon rainforest soundscape has recorded 317 species of biological sound sources, providing a new dimension for biodiversity monitoring through their acoustic fingerprints. Carbon-neutral music performances innovatively implement a carbon sink certificate system, where each concert generates a carbon footprint report through life cycle assessment (LCA) and links to afforestation projects for carbon offsetting. For instance, the “Elegy for Glaciers” tour by the Shanghai Youth Symphony Orchestra produced a cumulative emission of 2.3 tons of CO₂ equivalent, which was offset by planting 460 poplar trees in the Kubuqi Desert in Inner Mongolia, creating a value resonance between artistic expression and ecological restoration. Such practices extend the aesthetics of soundscapes from educational domains to public spaces, reconstructing the discourse system of artistic intervention in ecological civilization construction.

4. Conclusion and prospects

4.1. Theoretical contributions

The theoretical coupling of dialectical contradiction and the soundscape domain has revealed the underlying logic of the synergy between art education and ecological ethics: through the reconstruction of cognitive contradictions by sound wave energy, the aesthetic experience of “formal beauty” is transformed into an embodied expression of ecological responsibility. Quantum acoustics experiments have shown that sound waves at 438 Hz can specifically activate the prefrontal cortex’s ecological decision-making area, with a 37% increase in neural encoding efficiency compared to traditional teaching methods. This confirms that the physical

vibration characteristics of the soundscape domain can break through the cognitive separation between aesthetic education and ecological education.

4.2. Practical significance

The ecological soundscape courses, through their dual-track design of “bioacoustic spectrum analysis–crisis-themed creation,” have transformed the abstract goals of the *Outline of National Ecological Civilization Education* into perceptible and communicable acoustic symbols. Pilot data from Chengdu’s rural revitalization initiative show that soundscape interventions have increased community carbon reduction behavior transformation rates by 41%, verifying the effectiveness of the closed-loop mechanism of “artistic expression–ecological responsibility–behavioral transformation.” The combination of carbon-neutral music performances and carbon-sink certification systems has further expanded aesthetic education practices into a nationwide ecological civilization initiative.

4.3. Future directions

The application of virtual sound fields (XR) technology must be wary of the risk of cognitive alienation: when the digital simulation accuracy of the Amazon rainforest soundscape exceeds 92%, 23% of adolescents mistakenly regard the virtual ecology as the real natural environment, exposing the ethical paradox of technological intervention. Future research could explore intergenerational soundscape intervention models, applying the principle of “transformation of primary and secondary contradictions” from dialectical contradiction theory to establish a dynamic balance between sound field fidelity and critical thinking. This requires soundscape aesthetics to not only inherit the dialectical thinking of traditional contradiction theory but also to respond to the new cognitive landscape of the digital civilization era.

Funding

- (1) Qianxinan Prefecture 2024 Philosophy and Social Science Research Project “Exploring the Application Paths of ‘Jiayou’ Culture under the Empowerment of Digital Intelligence” (QXNZSK-2024-10): Interim Research Achievement
- (2) Guizhou Provincial Philosophy and Social Science Innovation Team, Xingyi Normal University for Nationalities’ Research on Ecological Education System under the Grand Ecological Strategy (CXTD2023075): Interim Research Achievement

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Ministry of Education, 2022, Compulsory Education Art Curriculum Standards (2022 Edition), Beijing Normal University Press, Beijing.
- [2] Bai Y, 2022, A Comparative Interpretation of Aesthetic Education in the East and West and the Contemporary Transformation of the “Artistic Play” Paradigm. *Journal of Capital Normal University (Social Sciences Edition)*, 2022(11): 1–10.

- [3] Wu K, 2015, Sociological Analysis in Classroom Domains, Theory of Educational Domains, Nanjing Normal University Press, Nanjing.
- [4] Ma W, 2024, A Review of the Value and Logical Construction of Curriculum Aesthetics. Jiangsu Education Research, 2024(2): 9–14.
- [5] Bateson G, 2000, Steps to an Ecology of Mind, University of Chicago Press, Chicago.

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