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Generative AI for Teaching-Learning-Assessment Integration in Primary and Secondary School Music Classrooms: Internal Logic, Risks, and Strategies

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ABSTRACT

With the continuing digital transformation of education, generative AI (GenAI) is increasingly discussed as a possible means of supporting the integration of teaching, learning, and assessment in primary and secondary school music classrooms. This article uses GenAI as the main term rather than repeatedly using the full expression generative artificial intelligence; the related term AI-generated content (AIGC) is retained only when the discussion concerns AI-produced digital content. From the perspective of classroom alignment, GenAI can support music teaching in four ways: by helping teachers specify competency-oriented learning objectives, by expanding and reorganizing music learning content, by generating differentiated pedagogical options, and by providing timely evidence for formative assessment. At the same time, the use of GenAI in music classrooms may create new risks: the algorithmic blurring of learning objectives, the cultural flattening of diverse musical traditions, the over-standardization of artistic guidance, and the narrowing of assessment to measurable indicators. To address these risks, this article proposes four strategies: maintaining teachers' pedagogical and ethical leadership, adapting GenAI-generated lesson plans through school-based curriculum development, developing music-specific large models and multimodal support tools, and building collaborative assessment mechanisms that combine quantitative analytics with professional artistic judgement. The study argues that GenAI should not replace teachers' aesthetic, cultural, and educational agency. Its value lies in supporting a more responsive and evidence-informed music classroom while remaining subordinate to the aims of aesthetic education.

Keywords: Generative AI, Genai, AI-Generated Content, AIGC; Music Education, Teaching-learning-assessment Integration, Formative Assessment.

1. Introduction

The Compulsory Education Art Curriculum Standards (2022 edition) require music classrooms to strengthen the consistency among teaching, learning, and assessment. They also encourage the appropriate use of modern media and digital technologies in arts education (Ministry of Education of the People's Republic of China [MOE], 2022). In practice, however, this consistency remains difficult to achieve. Music teachers often rely on experience-based judgement and periodic tests, and classroom feedback is frequently delayed, fragmented, or restricted to a small number of observable dimensions. This makes it difficult for teachers to diagnose students' musical understanding, performance development, and aesthetic experience in a timely manner (Guo, 2025).

In English-language educational research, the commonly used term is generative AI, often abbreviated as GenAI. This usage is more natural than repeatedly writing "generative artificial intelligence." GenAI refers to AI systems capable of producing new content, such as text, images, audio, video, code, and music, on the basis of patterns learned from large-scale data (UNESCO, 2023). The term AI-generated content (AIGC) is also used in technology research to describe digital content produced by AI models, but in education-focused writing GenAI is usually the more suitable umbrella term (Cao et al., 2023). Accordingly, this article uses GenAI as the primary term and reserves AIGC for cases where the emphasis is on generated content itself.

Current research has already examined data-driven teaching-learning-assessment (TLA) integration, the role of AI in subject teaching, and the potential of GenAI to support interdisciplinary innovation, geography teaching design, and English listening and speaking assessment (Dong & Chen, 2024; Liu et al., 2025; Pan & Huang, 2024; Wu, 2024; Wu et al., 2025). These studies show that GenAI can contribute to instructional design, resource generation, personalized learning, and learning analytics. Nevertheless, the music classroom has distinctive disciplinary features. Music learning is not only the acquisition of knowledge; it also involves embodied experience, auditory discrimination, cultural understanding, emotional expression, collaborative performance, and creative interpretation. Therefore, the direct transfer of general AI-based teaching models to music education may obscure the specific nature of musical learning.

This article asks how GenAI can support TLA integration in primary and secondary school music classrooms, what risks may emerge when it is used as a technological intermediary, and what strategies can keep its application pedagogically meaningful. The argument proceeds in three steps. First, the article clarifies the conceptual logic of GenAI-supported TLA integration in music classrooms. Second, it analyses the risks that may appear in the four key links of objectives, content, methods, and assessment. Third, it proposes strategies for using GenAI in ways that strengthen, rather than weaken, teachers' professional judgement and the cultural mission of music education.

2. The Conceptual Logic of GenAI-Supported TLA Integration in Music Classrooms

2.1 Conceptualising TLA Integration in Music Classrooms

TLA integration is not a mechanical combination of three classroom procedures. It refers to the alignment of learning objectives, teaching activities, student learning processes, and assessment evidence. In curriculum reform, TLA consistency is often regarded as a key route to improving the quality of classroom teaching (Cui, 2024). More specifically, learning-teaching consistency concerns the match between students' learning tasks and teachers' instructional arrangements; teaching-assessment consistency concerns whether assessment evidence can inform teaching decisions; and assessment-learning consistency concerns whether feedback helps students understand learning goals and improve their learning processes (Cui et al., 2023).

For music education, TLA integration must be interpreted through the core competencies of the arts curriculum. A music lesson should not simply move from "teaching a song" to "checking whether students can sing it." Rather, the learning objective should be connected to musical perception, artistic performance, creative practice, and cultural understanding. Teaching activities should provide experiences through which students can listen, sing, perform, compare, create, discuss, and reflect. Assessment should then collect evidence not only of technical accuracy but also of musical understanding, expressive quality, collaboration, and cultural interpretation.

Because classroom contexts are dynamic, predesigned objectives alone cannot guarantee alignment. Instructional alignment needs continuous evidence from students' learning processes and timely adjustment of teaching decisions. Research on learning-goal development has shown that carefully specified goals can enhance instructional alignment and student learning, but these goals must be interpreted in relation to real learning contexts (Duis et al., 2013). In this sense, GenAI can be understood as a technological intermediary that connects objectives, content, methods, and

assessment by providing generated resources, analytic feedback, and adaptive suggestions. Figure 1 presents the dynamic teaching path proposed in this article.

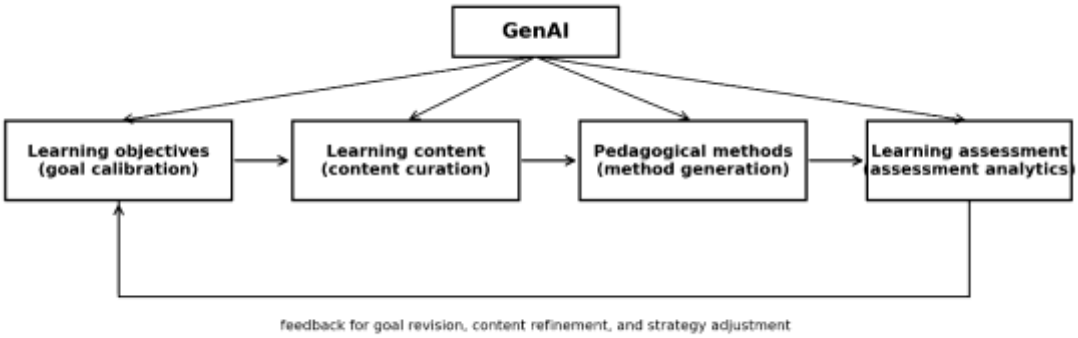

Figure 1. Dynamic teaching path of GenAI-supported TLA integration

2.2 Internal Mechanisms of GenAI-Supported TLA Integration

2.2.1 Clarifying Music Learning Objectives

Clear learning objectives are the starting point of a high-quality music lesson. If objectives are vague, overly broad, or unrelated to assessment criteria, teachers' teaching and students' learning may move in different directions. In the TLA framework, objectives should specify what students are expected to perceive, perform, understand, create, or evaluate. They should also indicate what kind of evidence will show that learning has occurred (Zhao, 2025).

GenAI can support teachers in translating broad curriculum expectations into more operational lesson objectives. For example, it can help reorganize an objective such as "students learn to sing the song" into a more precise sequence: identifying melodic contour, maintaining stable rhythm and pitch, understanding the cultural background of the work, and expressing the emotional character of the music. It can also generate alternative objective statements at different levels of difficulty, enabling teachers to choose objectives that match students' prior knowledge and classroom conditions.

However, GenAI should be used as a drafting and calibration tool rather than as an authority on curricular aims. Music teachers need to compare AI-generated objectives with curriculum standards, lesson content, students' actual needs, and the broader purpose of aesthetic education. Only when teacher judgement remains central can objective setting become more precise without becoming algorithmically determined.

2.2.2 Curating and Expanding Music Learning Content

Rich and well-organized learning content provides the material basis for TLA integration. In traditional music classrooms, teaching content is often constrained by textbook sequencing, limited teaching time, and teachers' access to resources. Such constraints can make it difficult to respond to students' differentiated interests and to connect classroom works with wider musical cultures. GenAI can help teachers gather, compare, summarize, and reorganize music-related materials in real time, thereby expanding the range of examples and learning pathways available in a lesson (Zheng et al., 2024).

In content curation, GenAI can support teachers in building multi-level resource networks. For a lesson on folk song, for instance, it can provide historical background, regional maps, lyrics explanations, performance contexts, timbral descriptions, and comparable examples from other musical traditions. For a lesson on instrumental music, it can help organize information about instrument families, playing techniques, sound characteristics, and representative works. This kind of content expansion can help students move beyond isolated listening and develop more contextualized musical understanding.

Nevertheless, content expansion is valuable only when it is guided by learning objectives. More content does not automatically mean better learning. Teachers need to filter AI-generated resources, verify factual accuracy, and select materials that support students' musical perception and cultural understanding. In a music classroom, the aim is not to display a large amount of information but to guide students into meaningful encounters with musical sound, practice, and culture.

2.2.3 Diversifying Pedagogical Methods

Diverse pedagogical methods are crucial for addressing differences in students' musical backgrounds, interests, and abilities. Data-driven education has been discussed as one way to respond to the tension between scale and personalization in schooling (Yang & Zhang, 2022). In the music classroom, this tension is particularly visible: students may differ greatly in pitch perception, rhythmic sensitivity, vocal range, instrumental experience, confidence, and cultural familiarity.

GenAI can assist teachers by generating differentiated learning activities. It can suggest listening tasks for students who need auditory scaffolding, rhythmic-body activities for students with strong kinaesthetic response, creative arrangement tasks for students with prior theory knowledge, or small-group performance tasks that combine different strengths. In this way, GenAI can help teachers design multiple routes toward the same learning objective instead of imposing a single activity on all students. This corresponds to the shift from blended teaching to human-AI collaborative teaching, in which AI supports teachers' design capacity while teachers retain responsibility for pedagogical decisions (Yi & Han, 2025).

In music education, however, method generation must respect the embodied and aesthetic nature of musical learning. A music lesson cannot be reduced to a sequence of prompts, worksheets, and automatic feedback. Teacher demonstration, peer listening, embodied imitation, ensemble coordination, and live expressive adjustment remain irreplaceable. GenAI can enrich method options, but teachers must decide which methods are educationally appropriate and musically meaningful.

2.2.4 Providing Timely Formative Assessment and Feedback

TLA integration requires assessment to be embedded in the learning process rather than placed only at the end of instruction. Formative assessment helps teachers understand where students are, where they need to go, and what support is needed. In the music classroom, timely feedback may involve pitch accuracy, rhythmic stability, pronunciation, breathing, timbre, ensemble balance, expressive intention, and reflective understanding.

GenAI and related learning analytics can assist teachers in collecting and interpreting classroom evidence. For example, AI-supported tools may analyse students' singing or instrumental recordings, generate feedback on rhythm and pitch, summarize classroom interaction data, or visualize changes in learning performance over time. Similar learning-analytics systems have been used to provide timely information for intervention and student support (Arnold & Pistilli, 2012). When used carefully, such evidence can help teachers adjust teaching pace, regroup students, and provide more targeted support.

The core value of GenAI-supported assessment lies in feedback, not scoring. Quantified data can inform teachers about certain technical aspects, but it cannot fully interpret musical expression, cultural meaning, or students' creative intention. Therefore, AI-generated feedback must be integrated with teacher observation, peer assessment, self-reflection, and performance-based evaluation.

3. Risks of Integrating GenAI into Music Classroom TLA Practices

The above analysis shows that GenAI can support the four links of objectives, content, methods, and assessment. Yet the same links also reveal potential risks. GenAI is not a neutral add-on. As a technological intermediary, it may reshape teachers' choices, students' experiences, and the value orientation of music education. These risks must be identified before GenAI is widely embedded in classroom practice.

3.1 Objective Drift: Algorithmically Blurred Music Learning Objectives

Within the TLA framework, learning objectives are the guiding element. If GenAI-generated suggestions become the hidden source of objectives, teachers may gradually lose control over the educational direction of the lesson. The curriculum standards emphasize the internal relationship among knowledge, practice, and cultural meaning (MOE, 2022). However, GenAI systems may recommend objectives on the basis of popularity, textual similarity, or frequently generated templates rather than students' developmental needs and the disciplinary logic of music.

This risk is closely related to the problem of human-technology relations in AI education. When teachers use AI tools habitually and uncritically, they may be "reverse-domesticated" by technology: instead of using technology to serve pedagogical goals, they may allow algorithmic recommendations to reshape those goals (Sun, 2021). For instance, if a system repeatedly recommends popular songs or entertainment-oriented activities because they seem attractive to students, a lesson may gradually move away from core objectives such as rhythm training, sight-singing, ensemble listening, or the understanding of traditional musical forms.

Such objective drift does not mean that popular or contemporary musical materials should be excluded. The issue is whether materials serve the learning objective. If the objective is cultural understanding, then popular adaptations may be useful only when they help students compare musical styles, trace cultural transformation, or understand musical meaning. If the objective is pitch accuracy or choral coordination, however, the same materials may distract from the necessary technical and musical focus.

3.2 Cultural Flattening: Diluting Differences among Musical Cultures

Music education carries cultural meanings. The content selected for classroom teaching shapes students' understanding of local, national, and global musical cultures. The risk of GenAI lies in the fact that its content generation often depends on existing data distributions and frequently repeated patterns. When the system generates lesson plans, repertoire explanations, or listening tasks, it may reproduce standardized descriptions and overlook the particularity of regional traditions, minority music, local performance contexts, and orally transmitted practices.

This can lead to cultural flattening. A GenAI-generated lesson plan may describe different musical cultures with similar adjectives, such as "lively," "beautiful," "distinctive," or "expressive," without explaining the concrete musical features through which those qualities are produced. In the long run, students may learn a general rhetoric of cultural diversity without acquiring the ability to hear, compare, and understand real differences in musical language. The classroom may then appear culturally rich while remaining interpretively shallow.

The risk is especially serious for Chinese traditional music and local musical heritage. Many such traditions rely on specific vocal techniques, dialectal pronunciation, melodic formulas, timbral aesthetics, performance conventions, and social occasions. If GenAI-generated content abstracts these traditions into generic background information, students' sense of cultural identity and musical specificity may be weakened rather than strengthened.

3.3 Pedagogical Over-Standardization: Generic Guidance for Artistic Performance

Teaching methods in music education must be responsive to students' bodies, voices, emotions, and interaction. GenAI can generate procedures and activities, but it may also encourage over-standardization. When methods are mainly derived from templates or quantitative indicators, teaching may become efficient but less sensitive to students' unique artistic development.

This risk can be seen in the guidance of singing and instrumental performance. AI-supported systems may detect pitch deviation, tempo instability, or rhythmic errors, but they cannot fully replace a teacher's live judgement of timbre, breathing, phrasing, articulation, expressive intention, and classroom atmosphere. In vocal learning, for example, a slight change in pitch may result from tension, breath support, emotional overexertion, or unfamiliarity with language. A teacher can interpret these causes through experience and interaction; a general AI system may only mark the deviation as an error.

Similarly, in instrumental learning, body posture, finger movement, touch, bowing, breathing, and ensemble listening all carry pedagogical significance. Motion-capture and audio-analysis technologies can provide useful data, but they are not yet able to capture the full meaning of embodied musical performance. If teachers rely too heavily on AI-generated guidance, students' creativity and personal style may be constrained by standardized feedback.

3.4 Assessment Narrowing: Reducing Musical Learning to Quantifiable Indicators

Assessment is the feedback mechanism of TLA integration. The risk of GenAI-supported assessment is that measurable data may become overvalued. In music education, many important learning outcomes are qualitative, situated, and interpretive. These include musical sensitivity, expressive

authenticity, collaborative awareness, cultural understanding, creative imagination, and the ability to reflect on one's own performance.

If assessment relies mainly on quantifiable indicators such as pitch accuracy, rhythm accuracy, written theory scores, or task-completion rates, the evaluation perspective will be narrowed. Students may be judged as successful because they meet technical criteria, even if their performance lacks expressive depth or cultural understanding. Conversely, students who show creative interpretation or emotional engagement may be undervalued because these qualities are difficult to measure automatically.

This does not mean that quantitative assessment is useless. Technical indicators can be highly valuable when they are used to support feedback. The problem occurs when such indicators are treated as the whole of musical learning. Music is both a sounding practice and a cultural-artistic experience. Assessment must therefore combine measurable evidence with professional judgement, student reflection, and contextual interpretation.

4. Strategies for GenAI-Supported TLA Integration in Music Classrooms

To make GenAI pedagogically useful, music educators need strategies that connect technical affordances with disciplinary values. The following four strategies correspond to the four risk areas identified above: objectives, content, methods, and assessment.

4.1 Learning Objectives: Maintaining Teachers' Pedagogical and Ethical Leadership

The first strategy is to maintain teachers' leadership in goal setting. GenAI should provide options, not determine the aims of the lesson. Music teachers need to examine AI-generated objectives against curriculum standards, the developmental characteristics of students, and the broader purpose of aesthetic education. In this sense, the teacher is not merely an operator of technology but the professional agent who judges whether technology serves education.

In practice, teachers can use a three-step procedure. First, they identify the core learning objective from the curriculum and the musical work itself. Second, they ask GenAI to generate possible objective statements, activity sequences, and assessment evidence. Third, they revise these outputs according to students' actual learning needs and the cultural meaning of the work. This procedure allows teachers to benefit from GenAI's efficiency while preventing the tool from displacing pedagogical judgement.

Teachers should also intentionally correct the entertainment bias that may appear in AI-generated recommendations. For example, if a system overemphasizes popular music examples, the teacher may reduce their proportion and add traditional repertoire, local musical materials, or examples that reveal important musical structures. In this way, the lesson can remain attractive to students while still supporting deeper musical and cultural learning.

4.2 Learning Content: Adapting GenAI-Generated Lesson Plans through School-Based Curriculum Development

The second strategy is to adapt GenAI-generated content through school-based curriculum development. GenAI can generate a standard lesson plan quickly, but standardization is precisely the problem if the plan ignores students' cultural background, local resources, and school

conditions. Therefore, AI-generated content should be treated as a draft that requires contextualization.

School-based adaptation can operate at three levels. At the resource level, teachers can add local musical examples, community performance traditions, school ensemble resources, or students' own musical experiences. At the interpretive level, teachers can revise generic descriptions into music-specific explanations of melody, rhythm, mode, timbre, vocal style, instrumental technique, and performance context. At the activity level, teachers can redesign tasks so that students listen, perform, compare, create, and evaluate in ways that are feasible in their own classroom.

This strategy is particularly useful for local cultural heritage. Research on school-based curriculum development has emphasized the value of integrating local cultural resources into teaching (Gong & Lei, 2021). In the music classroom, GenAI may provide a basic knowledge framework, but teachers need to connect this framework with local soundscapes, dialects, performance customs, and students' lived experiences. Such adaptation can help students build a pathway from hometown music to broader cultural understanding.

4.3 Pedagogical Methods: Developing Music-Specific Large Models and Multimodal Support Tools

The third strategy is to develop subject-specific models and multimodal tools for music education. General-purpose GenAI systems are often weak in non-textual and non-structured musical elements. Music teaching requires the analysis of pitch, rhythm, timbre, texture, gesture, movement, breathing, ensemble balance, and expressive intention. A music-specific model would therefore need training data and evaluation criteria that reflect the disciplinary characteristics of music.

Such a model should include multiple modules. A melody module could distinguish stylistic patterns in classical, folk, popular, and regional music. A rhythm module could identify regular metre, syncopation, compound rhythm, and culturally specific rhythmic patterns. A timbre module could support the recognition of instruments and vocal qualities. A performance module could connect audio input with gesture, posture, and movement data. These modules would not replace teachers but provide richer evidence for teachers' pedagogical decisions.

At the classroom level, multimodal tools could help teachers provide more precise and timely support. Audio sensors may detect pitch and rhythm deviations; motion-capture technologies may record posture or instrumental movement; and GenAI may summarize these data into feedback suggestions. Yet all such tools must be designed around music learning rather than around technical novelty. Their value depends on whether they help students hear more carefully, perform more expressively, and understand music more deeply.

4.4 Learning Assessment: Building a Collaborative Assessment Mechanism

The fourth strategy is to build a collaborative assessment mechanism. GenAI is suitable for supporting the collection and analysis of some forms of learning evidence, but it is not suitable as the sole judge of students' musical growth. A robust music assessment system should combine AI-

supported quantitative evidence, teacher-led qualitative judgement, peer feedback, and student self-reflection.

This collaborative mechanism can be organized around the principle of "assessment for teaching and assessment for learning." AI tools may provide information about pitch, rhythm, task completion, practice frequency, or changes in performance over time. Teachers then interpret these data in relation to the musical work, classroom context, and students' expressive intentions. Students can use feedback to understand their strengths and weaknesses, while peer assessment can help them learn to listen critically and respectfully.

For example, in assessing a song performance, the system may provide objective indicators of intonation and rhythm. The teacher may evaluate phrasing, diction, timbre, emotional expression, and stylistic appropriateness. Students may reflect on how they understood the work and how they adjusted their performance. The final assessment therefore becomes a dialogue among data, professional judgement, and learner reflection. This kind of mechanism can prevent assessment from becoming a narrow technical test and can better support students' holistic musical development.

5. Conclusion

GenAI offers new possibilities for the integration of teaching, learning, and assessment in primary and secondary school music classrooms. It can help teachers clarify learning objectives, enrich learning content, diversify teaching methods, and collect timely evidence for formative assessment. When used responsibly, it may support a more responsive, differentiated, and evidence-informed classroom.

At the same time, GenAI also brings risks that are especially important in music education. It may blur learning objectives, flatten musical-cultural differences, standardize artistic guidance, and narrow assessment to quantifiable indicators. These risks remind us that music education cannot be reduced to content generation or data processing. Music learning is embodied, aesthetic, cultural, emotional, and creative.

Therefore, the key question is not whether GenAI should be used, but how it should be positioned. GenAI should be understood as an auxiliary tool within teacher-led pedagogy. It can extend teachers' design capacity and provide additional learning evidence, but it must remain subordinate to teachers' professional judgement, students' musical growth, and the educational aims of aesthetic education. Only under this condition can GenAI contribute to high-quality TLA integration in music classrooms.

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