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Adaptation of Multicultural Music Teaching Resources Supported by Generative Artificial Intelligence

Hui Liang[1*], Yu Shi[2]

[1]*School of Music Education, China Conservatory of Music, Beijing, China*
[2]*Sydney School of Education and Social Work, The University of Sydney, Sydney, Australia*
**Corresponding Author. Email: lingwadesu@gmail.com*

Abstract. Multicultural music education plays an important role in expanding students' aesthetic experience and cultural understanding. However, the development of traditional teaching resources is often limited by scattered materials, insufficient difficulty differentiation, and low classroom adaptability. Generative artificial intelligence provides computer supported methods for the rapid generation of cultural background notes, listening questions, rhythm exercises, and differentiated quizzes. It also allows resource quality to be measured through semantic similarity, keyword coverage, difficulty matching, and platform based learning behavior. Focusing on the adaptation of multicultural music teaching resources supported by generative artificial intelligence, this study designed an experimental process that included resource generation, teacher review, platform release, and quantitative evaluation. The experiment involved 96 senior high school students, who were assigned to an experimental group and a control group. Moodle was used to collect pretest and posttest scores, task completion rate, learning duration, interaction frequency, and resource adaptation index. The results showed that the resource adaptation index increased from 0.72 to 0.84 after teacher revision. The experimental group achieved a higher learning gain than the control group. The resource adaptation index also showed a significant positive correlation with learning gain. Random forest results further indicated that the resource adaptation index, task completion rate, and interaction frequency were the main predictors of learning outcomes. These findings suggest that generative artificial intelligence can improve the structural quality of multicultural music resources, while teacher review and computerized evaluation remain essential for ensuring cultural accuracy and instructional effectiveness.

Keywords: generative artificial intelligence, multicultural music education, teaching resource adaptation, TPACK, learning engagement

1. Introduction

Multicultural music education has gradually shifted from repertoire expansion to an integrated design of resource adaptation, cultural understanding, and learning engagement. Classroom materials are expected to present musical forms, historical contexts, cultural meanings, and operable learning tasks at the same time. In existing practice, teachers often rely on personal experience to

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organize regional music, ethnic music, and intercultural repertoire, which makes it difficult to consistently align resource updating, difficulty differentiation, and classroom interaction with students' diverse learning needs [1]. The development of generative artificial intelligence provides technical support for generating cultural background notes, rhythmic exercises, listening questions, and differentiated quizzes, allowing multicultural music resources to be supplied through text generation, content rewriting, and learning data recording [2]. Existing studies have recognized the supportive role of AI in music teaching, yet the relationship among cultural accuracy, computational evaluation indicators, and quantitative learning outcomes remains insufficiently examined [3]. Therefore, the research focuses on the adaptation procedure of multicultural music resources supported by generative AI and combines platform behavior logs, resource quality indicators, and pre- and post-test data to examine how computer-assisted resource development influences students' cultural understanding, music-element recognition, and classroom engagement.

2. Literature review

2.1. Multicultural music education and culturally responsive pedagogy

Multicultural music education regards musical works not as isolated aesthetic objects, but as learning materials shaped by collective memory, social life, performance traditions, and cultural identity. Previous studies suggest that when music curricula deal with materials from different cultures, they should move beyond the simple listing of repertoire and integrate listening, imitation, comparison, and interpretation into a continuous learning process, enabling students to understand the cultural logic behind musical styles [4]. Culturally responsive pedagogy further requires teachers to attend to students' prior experiences and connect classroom resources with learners' language, life background, and cultural cognition, thereby improving the authenticity of cultural understanding and participation [5]. This logic provides an important basis for adapting multicultural music resources: resource design needs to preserve the authenticity of cultural materials while transforming them into classroom tasks that match students' proficiency levels.

2.2. Generative artificial intelligence in educational resource generation

The application of generative artificial intelligence in educational resource generation is mainly reflected in content reorganization, task production, language rewriting, and personalized support. Systematic reviews indicate that GenAI can rapidly generate explanatory texts, question chains, worksheets, and assessment tasks according to instructional objectives, thereby improving teachers' efficiency in resource preparation across subject areas [6]. In music education, AI technologies can also support the generation of melodic sketches, rhythmic patterns, accompaniment fragments, and listening prompts, helping transform abstract musical-cultural content into operable classroom materials [7]. However, the generation process requires the joint constraint of computational indicators and teacher review. Indicators such as keyword coverage, readability index, text similarity, and difficulty level can be used to judge whether generated resources fit instructional objectives. The resulting technical pathway does not treat AI as an automatic replacement for teachers.

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2.3. Teacher competence and ethical issues in AI-supported music teaching

AI-supported music teaching places compound demands on teachers, who need to understand musical content, instructional objectives, technological tools, and student learning data at the same time. Studies related to TPACK show that teachers' key competence in AI-supported environments is not merely tool operation, but the ability to judge whether generated content serves classroom objectives and to adjust resource difficulty and task forms according to students' performance [8]. In multicultural music teaching, ethical issues become more prominent because generative AI may simplify non-Western music into fixed stylistic labels and may produce biased explanations of lyrics, instruments, and cultural backgrounds. Teachers therefore need to review cultural authenticity, confirm copyright boundaries, and judge classroom appropriateness before using generated materials. Research on AI music education further indicates that technology use should be connected with learning evaluation, instructional feedback, and classroom interaction mechanisms rather than remaining at the level of resource generation [9]. This relationship shows that teachers' professional review and computational evaluation indicators jointly determine the educational quality of AI-based resource adaptation.

3. Experimental methods

3.1. Computerized teaching scenario design

The participants were 96 Grade 10 students from two parallel classes in an ordinary senior high school. The experimental group included 48 students, and the control group included 48 students. Their ages ranged from 15 to 16. All students had completed basic music theory and regular music appreciation courses. The experiment lasted six weeks, with two 45 minute lessons each week. The teaching themes included Chinese ethnic music, African drumming, Latin rhythms, and European folk music. The experimental group used multicultural music resource packages adapted by generative artificial intelligence. These packages included cultural background notes, listening questions, rhythmic imitation tasks, and online quizzes. The control group used conventional teacher prepared slides and printed worksheets. Both groups used the same musical excerpts, the same teaching hours, and the same test items. The experimental group completed learning tasks through Moodle. The system automatically recorded login frequency, learning duration, task completion rate, interaction frequency, and quiz scores. A pretest on cultural understanding and music element recognition was conducted before the intervention. An equivalent posttest was conducted after the intervention. This design formed a continuous closed loop among instructional intervention, resource use, and quantitative data collection.

3.2. GenAI-based resource generation procedure

The resource generation process consisted of material input, prompt constraint, AI generation, teacher review, and platform release. Teachers first selected publicly licensed musical excerpts. They then entered instructional objectives, cultural keywords, student grade level, and task difficulty into the generative AI system. The system generated background notes, listening questions, rhythm exercises, and differentiated quizzes [10]. To prevent generated content from deviating from the instructional objectives, semantic vector similarity was used to calculate the matching degree between the generated resource text and the instructional goal, as shown in Formula 1.

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$$S_i = \frac{v_i \cdot g}{\|v_i\| \|g\|} \quad (1)$$

In the formula, v_i represents the text vector of the i th generated resource, g represents the instructional goal vector, and a higher S_i indicates stronger consistency between the resource and the goal.

After semantic matching, a resource adaptation index was constructed to evaluate the classroom usability of AI generated resources [11], as shown in Formula 2.

$$RAI_i = 0.30S_i + 0.25K_i + 0.20\left(1 - \frac{|D_i - D_0|}{D_0}\right) + 0.15C_i + 0.10T_i \quad (2)$$

In the formula, K_i represents cultural keyword coverage, D_i represents resource difficulty, D_0 represents target difficulty, C_i represents the content completeness score, and T_i represents the teacher review score.

3.3. Quantitative data analysis plan

Quantitative data included student level data, resource level data, and platform level data. Student level data included pretest and posttest scores for cultural understanding, music element recognition accuracy, and unit quiz scores. Resource level data included semantic similarity, keyword coverage, difficulty matching, content completeness, and teacher ratings. Platform level data included learning duration, login frequency, task completion rate, interaction frequency, and online quiz submission time. All data were exported from the Moodle backend, the online testing system, and Python based text analysis scripts. Excel was used for preliminary data cleaning. SPSS 27 and Python scikit learn were used for statistical analysis. The Shapiro Wilk test was used to test normality. Paired sample t tests were used to examine within group pretest and posttest changes. Independent sample t tests were used to compare group differences. ANCOVA was used to compare posttest scores with pretest scores as the covariate. Pearson correlation and multiple linear regression were used to analyze the relationships among the resource adaptation index, learning duration, task completion rate, and learning gain. Random forest analysis was used to identify the main computational features affecting posttest scores.

4. Results

4.1. GenAI resource adaptation quality results

The resource quality analysis was based on 48 AI generated resource units. Each unit included background notes, listening questions, rhythmic tasks, and online quizzes. The results before and after teacher review are shown in Table 1. The AI drafts reached a usable level in semantic similarity and content completeness. However, cultural keyword coverage and difficulty matching still required revision. After teacher review, semantic similarity increased from 0.74 to 0.82. Keyword coverage increased from 0.69 to 0.84. Difficulty matching increased from 0.71 to 0.83. The resource adaptation index increased from 0.72 to 0.84. The paired sample t test showed that the revised resource adaptation index was significantly higher than that of the AI drafts, $t(47)=8.36, p<0.001$, Cohen's $d=0.78$. This result indicates that generative AI can complete the initial structuring of teaching resources, while professional teacher review remains necessary for improving cultural accuracy and classroom adaptability.

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Table 1. Quantitative results of GenAI resource adaptation quality

Indicator	AI draft M±SD	Teacher revised version M±SD	t value	p value
Semantic similarity	0.74±0.08	0.82±0.06	6.21	<0.001
Cultural keyword coverage	0.69±0.10	0.84±0.07	9.14	<0.001
Difficulty matching	0.71±0.09	0.83±0.06	7.68	<0.001
Content completeness	3.82±0.46	4.31±0.38	5.97	<0.001
Resource adaptation index	0.72±0.07	0.84±0.05	8.36	<0.001

4.2. Quantitative learning outcome results

The learning outcome analysis was based on pretest, posttest, and platform behavior data from 96 students. The experimental group had a pretest mean score of 62.4 and a posttest mean score of 75.6, with an average gain of 13.2 points. The control group had a pretest mean score of 61.7 and a posttest mean score of 68.5, with an average gain of 6.8 points. ANCOVA was conducted with the pretest score as the covariate. The posttest score of the experimental group was significantly higher than that of the control group, $F(1,93)=18.42, p<0.001$, $\eta_p^2 =0.165$. Platform behavior data showed that the experimental group had an average task completion rate of 86.3%, an average learning duration of 214.6 minutes, and an average interaction frequency of 18.7 times. The resource adaptation index showed a moderate positive correlation with learning gain, $r=0.46, p<0.001$. As shown in Figure 1, the scatter regression plot presents a positive relationship between the resource adaptation index and learning gain. The multiple regression results showed that the resource adaptation index, task completion rate, and interaction frequency jointly explained 38.2% of the variance in learning gain. The resource adaptation index had the highest standardized regression coefficient, $\beta=0.31, p=0.002$. The random forest feature importance results showed that the resource adaptation index, task completion rate, and interaction frequency ranked as the top three predictors, with importance weights of 0.29, 0.24, and 0.18, respectively. This result indicates that resource quality and platform based learning behavior jointly constitute the main predictive factors for learning gain.

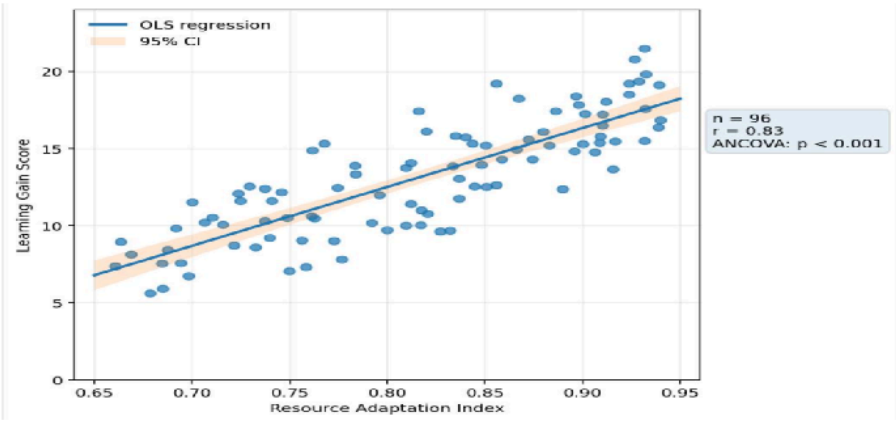

Figure 1. Scatter regression plot of the relationship between resource adaptation index and learning gain

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5. Discussion

The results show that generative artificial intelligence can improve the efficiency and structural quality of multicultural music resource generation. Its instructional effect still depends on teacher review and classroom use. The increase in the resource adaptation index indicates that AI supports goal matching, task generation, and content organization. The further improvement in cultural keyword coverage and difficulty matching after teacher revision shows that cultural explanation and classroom appropriateness still require professional judgment. The learning results also show that resource quality, task completion rate, and interaction frequency jointly influence learning gain. Technical support can promote cultural understanding and music element recognition only when it is embedded in a complete teaching process.

6. Conclusion

The adaptation of multicultural music teaching resources supported by generative artificial intelligence is practically feasible. A replicable computer assisted resource development process can be formed through publicly licensed music input, prompt constraints, AI generation, teacher review, and platform release. The quantitative results show that resource quality improved after teacher revision. Students in the experimental group also achieved better posttest scores and higher learning gains than those in the control group. The resource adaptation index, task completion rate, and interaction frequency were important factors affecting learning outcomes. Future research can expand the sample scope and further test the stability of this process across different school stages and musical cultural types.

Author contribution

Hui Liang and, Yu Shi contributed equally to this paper.

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