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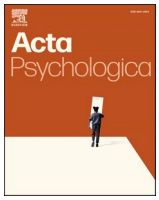

Fusion and innovation-advancing sustainability through hybrid musical genres in education

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ABSTRACT

This empirical study examines the influence of hybrid musical genres on innovation in education, sustainability awareness, and student engagement within the context of music education. The research employed a quantitative methodology with a structured questionnaire adapted from previous studies, focusing on four dimensions of hybrid musical genres: cultural fusion, genre blending, innovation in composition, and technological integration. The sample consisted of students from various educational institution, primarily aged between 18 and 22 years, who provided data through a Likert-scale based survey. The findings reveal that hybrid musical genres significantly enhance innovation in education, which in turn promotes sustainability awareness and increases student engagement. Specifically, the results supported the hypothesis that innovation in education mediates the relationship between hybrid musical genres and student engagement, while also enhancing students' awareness of sustainability issues. Furthermore, the study confirmed that technological integration within hybrid musical genres positively influences the effectiveness of innovative educational practices. These findings highlight the potential of integrating hybrid musical genres into educational curricula to foster a more engaging, innovative, and sustainability-conscious learning environment. The study contributes to the literature by highlighting the role of music education in promoting sustainability and innovation, offering practical implications for educators and policymakers seeking to enrich educational outcomes through the arts.

1. Introduction

Hybrid musical genres represent a pivotal variable in exploring the intersection of cultural diversity and educational innovation (Kostrzewa et al., 2022). The theoretical importance of this construct lies in its potential to foster cultural competence and stimulate creative thinking among students (Alcalde, 2022; Jena et al., 2023). Academically, hybrid musical genres serve as a lens through which students can explore and integrate diverse musical traditions, thereby enhancing their global musical understanding and appreciation. This integration encourages not only a deeper engagement with the material but also promotes a more inclusive approach to music education.

Empirically, the integration of hybrid musical genres into educational settings has been linked with heightened creativity and a deeper engagement with music as both an art form and a medium of personal expression. For instance, research by Wilson (2022a, 2022b) highlighted that students exposed to curricula that included diverse musical genres demonstrated more advanced skills in musical composition and interpretation compared to those who followed more conventional music studies. Additionally, Sideboard (2023) found that hybrid musical curricula foster not only musical proficiency but also critical thinking and empathy among students, as they learn to navigate and integrate diverse cultural perspectives. Such findings suggest that hybrid musical genres not only enrich the student's learning experience but also equip them with the skills to think and create beyond traditional music education frameworks. These insights establish hybrid musical genres as a significant educational tool that can bridge cultural divides and inspire innovation in the way music is taught and experienced.

While the influence of hybrid musical genres on innovation in education has begun to receive scholarly attention (Li et al., 2021), significant gaps remain in our understanding of how these genres specifically facilitate innovative educational practices. Theoretically, hybrid musical genres are posited to catalyze creativity within the classroom by introducing students to a fusion of sounds and musical techniques that defy traditional categorizations (Cruywagen & Potgieter, 2020). This exposure theoretically encourages educators to adopt more flexible and innovative teaching approaches, aligned with the diverse musical content (Camlin & Lisboa, 2021). However, empirical research examining

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the direct links between hybrid musical genres and specific innovative educational outcomes is still sparse.

Furthermore, there is a theoretical significance in exploring this relationship, as it could substantiate claims about the broader educational impacts of cultural diversity and interdisciplinary learning. Music, by its nature, serves as a powerful medium for conveying complex cultural histories and narratives; integrating diverse musical forms can therefore transform educational environments, making them more inclusive and dynamic (Beirnes & Randles, 2023). This potential for hybrid musical genres to serve as a catalyst for educational innovation aligns with contemporary educational theories that emphasize experiential learning and cultural inclusivity (Gibson, 2021). Yet, detailed studies that map out the specific mechanisms through which hybrid musical genres influence educational practices and learner engagement remain inadequate. Addressing this gap could significantly enhance our understanding of the transformative potential of music in education, providing empirical support for innovative curriculum design that reflects our increasingly globalized society.

The integration of hybrid musical genres into educational settings can catalyze innovation in education, which subsequently promotes sustainability awareness among students. While the link between innovative educational practices and enhanced sustainability awareness is conceptually appealing, empirical evidence specifically detailing how musical diversity influences these educational outcomes remains scant. Research by Gorbunova and Plotnikov (2020) suggests that innovative educational approaches, influenced by diverse musical genres, tend to incorporate themes of global interconnectedness and environmental responsibility more effectively. However, the pathways through which hybrid musical genres directly foster innovation in education and subsequently enhance sustainability awareness are not well-documented. This highlights a significant research gap, underlining the need for studies that explicitly investigate how exposure to varied musical traditions can spur educational innovations that in turn raise sustainability consciousness. Addressing this gap could provide valuable insights into designing curricula that not only foster creative and critical thinking but also instill a strong sense of environmental stewardship in students.

Accordingly, increasing sustainability awareness through innovative educational practices can significantly boost student engagement, a relationship that accentuates the potential of a serial mediation model involving hybrid musical genres, innovation in education, and sustainability awareness. Studies, such as those by Weng and Chen (2020), have shown that when students understand sustainability concepts deeply—often through innovative and interactive learning methods (Pacis & VanWynsberghe, 2020)—they engage more actively with the curriculum, driven by a sense of relevance and urgency about global issues. This engagement is not merely academic but involves a profound personal connection to the learning material, which can be particularly enhanced through the arts, such as music, that evoke emotional and cognitive responses. The proposed serial mediation model in this study suggests that hybrid musical genres can initiate a cascade effect where they first stimulate innovation in education, which then enhances sustainability awareness, ultimately leading to increased student engagement. This model not only aligns with theoretical frameworks that advocate for integrated learning approaches but also fills a crucial empirical gap by detailing the specific pathways through which music education can contribute to broader educational outcomes. Such insights are vital for educators and policymakers aiming to cultivate more engaging and environmentally conscious educational environments (Fig. 1).

2. Hypotheses

2.1. Hybrid musical genres and student engagement

Hybrid musical genres offer an innovative approach to music education by blending diverse musical styles to create unique sounds (Li et al., 2021). Beyond enriching the musical landscape, they serve as powerful tools for cultural education and cognitive diversity. As noted by Hollander-Shabtai and Tzofi (2022), these genres challenge traditional musical boundaries, encouraging learners to think beyond conventional categories and engage with music on a deeper, more reflective level.

Academic literature conceptualizes hybrid musical genres as a multidimensional construct, incorporating cultural fusion, genre blending, innovation in composition, and technological integration (Gioti, 2020; Hollander-Shabtai & Tzofi, 2022; Li et al., 2021; Machado et al., 2021; McPherson et al., 2020; Xiao, 2022). Cultural fusion integrates musical elements from different traditions, broadening students' understanding of global music (McPherson et al., 2020). Genre blending combines distinct musical styles, such as jazz with classical or electronic with folk, fostering versatility and creativity (Machado et al., 2021). Innovation in composition encourages students to explore new musical techniques, fostering experimentation and creativity (Gioti, 2020). Lastly, technological integration enhances music production and education, equipping students with digitally relevant skills (Xiao, 2022).

Research suggests that exposure to diverse and innovative musical content enhances student engagement, increasing interest and participation in learning activities (Chen & O'Neill, 2020). Hybrid musical genres stimulate curiosity and motivation, immersing students in rich cultural and musical experiences. Their incorporation into curricula fosters dynamic learning environments, deepening students' appreciation of music as both an art form and a cultural expression (Beirnes, 2022). Beyond music education, engagement with hybrid genres supports broader academic and social skill development, positioning them as a key component of holistic education. Thus, it is hypothesized that:

H1. There will be a positive relationship between hybrid musical

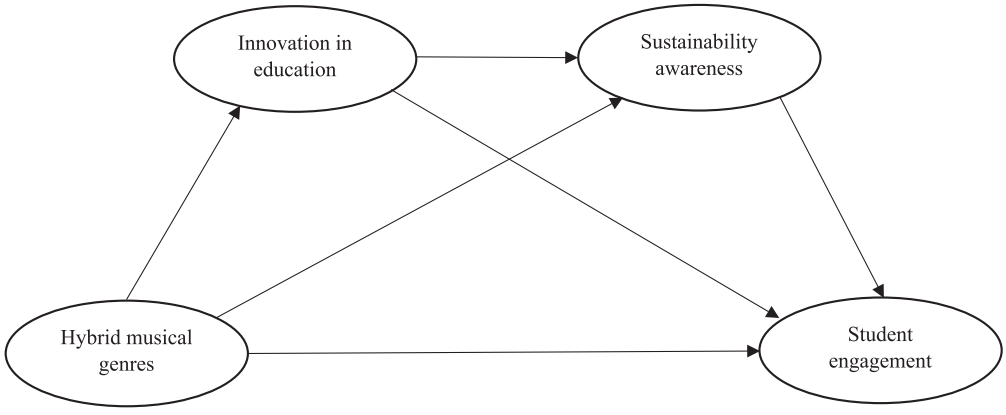

Fig. 1. Conceptual model.

genres and student engagement.

2.2. Hybrid musical genres and innovation in education

The relationship between hybrid musical genres (HMGs) and innovation in education is expected to be positive and significant, as these genres integrate diverse musical traditions and technological advancements, fostering creativity and innovative thinking in educational settings (Jena et al., 2023). Exposure to varied musical styles broadens students' musical perspectives, encouraging them to think critically and creatively about music composition and interpretation (Sideboard, 2023). This dynamic learning environment promotes openness to new ideas and teaching methods, making HMGs a catalyst for educational innovation (Ng et al., 2022). Educators may incorporate these genres into curricula through case studies in music composition, cultural studies, and technology integration, fostering a more interactive and interdisciplinary approach to learning. The theoretical link between HMGs and educational innovation suggests that both students and teachers who engage with these genres are more likely to adopt creative instructional methods, integrate digital tools in music education, and explore interdisciplinary connections (Camlin & Lisboa, 2021). By influencing both content and pedagogy, HMGs serve as a transformative force in education, driving innovation in teaching and learning. Thus, it is hypothesized that:

H2. There will be a positive relationship between hybrid musical genres and innovation in education.

2.3. Mediating role of innovation in education

The mediating role of innovation in education between hybrid musical genres (HMGs) and student engagement is crucial in understanding how diverse musical influences enhance learning. By blending various musical styles and cultural elements, HMGs create a rich auditory experience that invigorates the educational environment (Li et al., 2021). This exposure encourages educators to adopt innovative teaching strategies that cater to diverse learning styles and interests (Jena et al., 2023).

Innovation in education translates the creative and cultural richness of HMGs into interactive, collaborative, and technology-driven teaching practices, fostering deeper student engagement (Wilson, 2022a, 2022b). Educators can integrate hybrid genres into coursework through composition-based assignments and cultural analysis activities, encouraging student creativity and active participation (Crawford, 2020a, 2020b). Empirical studies indicate that students engaged in innovative, music-based instructional methods show higher levels of motivation, academic achievement, and cognitive development (Crawford, 2020a, 2020b). This engagement extends beyond surface-level participation, enhancing problem-solving abilities and cultural awareness. Therefore, innovation in education serves as a key mediator by leveraging HMGs to foster a dynamic and immersive learning experience. Hence,

H3. Innovation in education will mediate the association between hybrid musical genres and student engagement.

2.4. Hybrid musical genres and sustainability awareness

The influence of hybrid musical genres (HMGs) on sustainability awareness highlights their potential to foster environmental and social consciousness through cultural fusion and technological innovation. By exposing students to global musical traditions, HMGs deepen their understanding of how environmental changes impact cultures and artistic expressions.

Technological innovation within HMGs often incorporates sustainable practices, such as digital music production, which reduces waste and energy consumption (Xiao, 2022). Students engaged in music creation using these technologies develop a greater awareness of the environmental implications of artistic choices (Gioti, 2020). Additionally, interdisciplinary learning—inherent to HMGs—enhances students' engagement with sustainability issues (de Moya Martínez & Syroyid Syroyid, 2021; Guo et al., 2020). Integrating arts and environmental education makes sustainability more tangible and relevant, enriching students' learning experiences and ecological awareness. Therefore, it is hypothesized that:

H4. There will be a positive relationship between hybrid musical genres and sustainability awareness.

2.5. Mediating role of sustainability awareness

The mediating role of sustainability awareness between hybrid musical genres (HMGs) and student engagement highlights how musical exposure fosters deeper connections to societal issues, particularly sustainability. HMGs serve as a catalyst for both musical appreciation and environmental consciousness, which in turn enhances student engagement.

By integrating HMGs into education, students are introduced to cultural narratives and the ecological and social challenges affecting different communities (Kostrzewa et al., 2022). As they explore the relationship between music and culture, they naturally encounter sustainability themes, such as the impact of environmental change on traditional music and the role of music in social equity and environmental advocacy (Navbakhor, 2020). This exposure increases students' awareness of environmental, social, and cultural interconnectedness, strengthening their engagement with learning content that reflects real-world issues (Grant & Low-Choy, 2021).

Sustainability-aware students tend to participate more actively in coursework integrating ecological themes, as seen in studies showing that understanding sustainability implications enhances motivation and engagement (Bojner Horwitz et al., 2022). This bridging role of sustainability awareness underscores the educational value of HMGs in addressing global challenges while maximizing student engagement and learning outcomes. Therefore,

H5. Sustainability awareness will mediate the association between hybrid musical genres and student engagement.

2.6. Innovation in education and sustainability awareness

The relationship between innovation in education and sustainability awareness highlights how new teaching methodologies enhance students' engagement with environmental issues. Interdisciplinary approaches that merge arts, science, and social studies foster a comprehensive understanding of sustainability. Innovative strategies such as project-based and experiential learning, along with technology integration, encourage critical thinking and problem-solving in sustainability education (Cao, 2021). Students involved in projects that investigate and propose solutions to real-world environmental challenges develop deeper knowledge and a stronger sense of responsibility. Integrating sustainability into curricula through creative and interactive learning methods helps students recognize the connections between human behavior, environmental impact, and societal values (Guo et al., 2020). Research further supports that students engaged in innovative educational practices demonstrate improved understanding of complex sustainability concepts (Ng et al., 2022). Thus, the link between innovation in education and sustainability awareness is essential for preparing environmentally conscious and proactive students. Hence,

H6. There will be a positive relationship between innovation in education and sustainability awareness.

2.7. Serial mediation model

The proposed serial mediation model hypothesizes that hybrid musical genres (HMGs) in education first foster innovation in teaching and learning, which subsequently enhances sustainability awareness, ultimately leading to increased student engagement. The introduction of HMGs, blending diverse musical styles and cultural influences, stimulates creative and inclusive teaching methodologies (Alcalde, 2022; Álvarez-Huerta et al., 2022). This fosters interdisciplinary learning, integrating elements from technology, history, and environmental studies, exposing students to new perspectives and innovative educational approaches (Ellefsen & Karlsen, 2020).

The second mediating effect occurs as educators embed sustainability themes into curricula using innovative frameworks. Discussions on the environmental impact of cultural practices or projects promoting sustainable music production help raise students' environmental consciousness (Du & Leung, 2022). This sustainability awareness enhances both emotional and cognitive engagement, as students see the real-world relevance of their learning (Acosta-Gonzaga & Ruiz-Ledesma, 2022). Feeling empowered to contribute positively to societal and environmental change increases their motivation and active participation (Iqbal et al., 2022). Thus, the serial mediation model illustrates how HMGs initiate a chain reaction—driving innovation in education, strengthening sustainability awareness, and culminating in heightened student engagement. Thus,

H7. Innovation in education and sustainability awareness will serially mediate the relationship between hybrid musical genres and student engagement.

2.8. Research methodology

The research methodology for this study involved a quantitative approach centered on the distribution and analysis of structured questionnaires to assess the impact of hybrid musical genres on innovation in education, sustainability awareness, and student engagement. A total of 500 questionnaires were administered to a diverse sample of students across multiple educational institutions, which were selected to represent a variety of demographics and academic backgrounds. The sample was selected using a purposive sampling technique to ensure that participants who were actively engaged in music education programs or showed a particular interest in hybrid musical genres were included. This method was chosen to facilitate deeper insights into how these genres influence educational outcomes, as participants with relevant experience or interest in the subject are more likely to provide informed and nuanced responses.

While this study includes students from multiple educational institutions, its findings may have limited generalizability due to the specific educational and cultural contexts in which the data was collected. To enhance applicability, future research should consider expanding the sample to encompass a broader range of students from diverse educational backgrounds, including different academic disciplines, geographic regions, and institutional settings. A comparative analysis across various educational systems could provide a more comprehensive understanding of the impact of hybrid musical genres in different learning environments.

The questionnaires were distributed both electronically and in paper form, depending on the accessibility and preferences of the participants. This dual-mode distribution was intended to maximize response rates and accommodate different respondent preferences. After the completion of the data collection phase, 419 questionnaires were screened for completeness and relevance, with those meeting the required criteria being processed for analysis. This rigorous screening ensured that the analysis was based on high-quality and reliable data.

The study involved 419 respondents from various educational institutions, selected through purposive sampling to ensure relevance to the research focus on hybrid musical genres in education. The average age of respondents was approximately 22 years, with 27 % falling within the 18–22 age group, 37 % falling within the 23–30 age group, and 36 % falling over 31 years. Gender distribution was relatively balanced with 53 % male and 47 % female respondents. Regarding educational level, 19 % were high school students, 41 % were undergraduate students, and 40 % were pursuing postgraduate studies. This diversity allowed for a comprehensive analysis of the effects of hybrid musical genres across different educational stages (Table 1).

2.9. Research instruments

The study utilized a quantitative approach and employed a questionnaire adapted from previous research. The instrument was designed to measure various constructs relevant to the integration of hybrid musical genres in education and their impacts on innovation, sustainability awareness, and student engagement.

Hybrid musical genres was measured using a 24-item scale adapted from prior studies (Gioti, 2020; Hollander-Shabtai & Tzofi, 2022; Li et al., 2021; Machado et al., 2021; McPherson et al., 2020; Xiao, 2022). This scale includes four dimensions: cultural fusion, genre blending, innovation in composition, and technological integration. For example, a sample item for cultural fusion is “The integration of diverse cultural music enhances my understanding of different traditions.” Each item was rated on a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree.”

Innovation in education was assessed with a 15-item scale, also adapted from previous research. The scale captures various aspects of innovative practices in music education (Beirnes, 2022; Ng et al., 2022). A sample item from this scale is “Teachers frequently introduce new ideas in music lessons.” Respondents rated each item on a 5-point Likert scale from “Strongly Disagree” to “Strongly Agree.”

Sustainability awareness was evaluated using a 5-item scale adapted from existing literature. This scale focuses on the integration of sustainability themes in music education (de Moya Martínez & Syroyid Syroyid, 2021; Guo et al., 2020). An example item is “Our music education includes lessons on the importance of sustainability.” Participants indicated their agreement with each statement on a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree.”

Student engagement was measured with a 7-item scale derived from prior studies (Beirnes, 2022; Chen & O'Neill, 2020). This scale assesses the level of student engagement in music classes that incorporate hybrid musical genres. A representative item is “I actively participate in music classes that use hybrid genres.” Responses were recorded on a 5-point Likert scale from “Strongly Disagree” to “Strongly Agree.”

Table 1
Demographic.

	Count	Percentage (%)
Total respondents	419	100
Age group		
18–22 years	113	27
23–30 years	155	37
31+ years	151	36
Gender		
Male	222	53
Female	196	47
Education		
High School Students	79	19
Undergraduate Students	171	41
Postgraduate Students	167	40

2.10. Control variables

To ensure the robustness of our findings, we controlled for several potential confounding variables that could influence the relationship between hybrid musical genres and educational outcomes. Specifically, we accounted for prior musical training, as students with formal music education may exhibit higher engagement levels regardless of musical genre exposure. Additionally, institutional teaching methodologies were considered by selecting participants from diverse educational institutions to mitigate biases related to specific pedagogical approaches. Furthermore, we controlled for demographic factors such as age, gender, and educational level, which could impact students' engagement and sustainability awareness. By addressing these variables, we aimed to enhance the validity of our results and isolate the effects of hybrid musical genres within the educational context.

3. Results

The analysis of the validity and reliability of constructs used in this study indicates robust psychometric properties, supporting the use of these measures in assessing the impact of hybrid musical genres on innovation in education, sustainability awareness, and student engagement. Factor loadings for all items related to the constructs—cultural fusion, genre blending, innovation in composition, technological innovation, innovation in education, sustainability awareness, and student engagement—were well above the recommended threshold of 0.7, demonstrating strong item reliability and convergent validity. This suggests that each item reliably measures its respective construct. Furthermore, the average variance extracted (AVE) for each construct exceeded the 0.5 mark, further confirming good convergent validity, and the composite reliability (CR) values were above the 0.7 threshold, indicating high internal consistency. These values are in line with the guidelines suggested by Hair et al. (2019); Ringle et al. (2020), who emphasize the importance of these metrics in assessing the measurement model's reliability and validity in partial least squares structural equation modeling (PLS-SEM) studies. Besides, Cronbach's alpha, another measure of internal consistency, also supported the reliability of the constructs, with all values well above the acceptable limit of 0.7. This consistency across various reliability measures underscores the robustness of the questionnaire and the validity of the constructs within the context of the study.

Overall, the validity and reliability metrics presented in Table 2 provide a solid foundation for the subsequent analysis of the structural model, ensuring that the constructs are well-defined and accurately measured, thus enhancing the credibility and generalizability of the study findings.

Subsequently, the heterotrait-monotrait (HTMT) ratio analysis presented in Table 3 provides insight into the discriminant validity of the constructs involved in the study of hybrid musical genres' impact on innovation in education, sustainability awareness, and student engagement. The HTMT values, as recommended by Henseler et al. (2015), should ideally be below 0.85 to affirm that constructs are distinct and do not overlap excessively with one another, ensuring discriminant validity. In this dataset, the HTMT ratios between different constructs such as cultural fusion, genre blending, innovation in composition, technological innovation, innovation in education, sustainability awareness, and student engagement demonstrate sufficient discriminant validity.

These results are crucial as they confirm that despite the constructs being related theoretically, they are statistically distinct, thus supporting the integrity of the structural model used in this study. By ensuring that the constructs do not overlap more than they theoretically should, the study upholds the robustness of its findings, allowing for more accurate interpretations and implications regarding the effects of hybrid musical genres in educational settings.

Table 4 provides additional validation for the higher-order construct (HOC) – hybrid musical genres, including cultural fusion, genre blending, innovation in composition, and technological innovation, by detailing their factor loadings, composite reliability (CR), Cronbach's alpha, and average variance extracted (AVE). This data confirms both the reliability and convergent validity of the constructs, which is essential for the robustness of the study's findings.

The factor loadings for each dimension of hybrid musical genres are significantly strong, all well above the recommended threshold of 0.7, which suggests that each item reliably measures its respective construct. Composite reliability and Cronbach's alpha are both used to measure the

Table 2
Validity and reliability for constructs.

	Loadings	AVE	CR	Cronbach's alpha
Hybrid musical genres		0.611	0.908	0.871
Cultural fusion				
CF1	0.719			
CF2	0.783			
CF3	0.852			
CF4	0.813			
CF5	0.702			
CF6	0.810			
Genre blending		0.623	0.891	0.847
GB7	0.712			
GB8	0.798			
GB9	0.831			
GB10	0.729			
GB11	0.838			
GB12	0.818			
Innovation in composition		0.677	0.880	0.835
IC13	0.723			
IC14	0.834			
IC15	0.799			
IC16	0.872			
IC17	0.853			
IC18	0.844			
Technological innovation		0.640	0.889	0.854
TI19	0.832			
TI20	0.744			
TI21	0.835			
TI22	0.723			
TI23	0.844			
TI24	0.814			
Innovation in education		0.627	0.885	0.829
IE1	0.875			
IE2	0.712			
IE3	0.844			
IE4	0.792			
IE5	0.790			
IE6	0.786			
IE7	0.821			
IE8	0.784			
IE9	0.795			
IE10	0.803			
IE11	0.825			
IE12	0.752			
IE13	0.775			
IE14	0.715			
IE15	0.798			
Sustainability awareness		0.622	0.892	0.847
SA1	0.827			
SA2	0.815			
SA3	0.712			
SA4	0.832			
SA5	0.753			
Student engagement		0.636	0.909	0.853
SE1	0.849			
SE2	0.722			
SE3	0.845			
SE4	0.813			
SE5	0.815			
SE6	0.691			
SE7	0.833			

Notes. CF – cultural fusion; GB – genre blending; IC – innovation in composition; TI – technological innovation; IE – innovation in education; SA – sustainability awareness; SE – student engagement.

Table 3
Heterotrait-monotrait (HTMT) ratio.

	CF	GB	IC	TI	IE	SA	SE
CF							
GB	0.543						
IC	0.472	0.445					
TI	0.451	0.752	0.425				
IE	0.731	0.731	0.282	0.342			
SA	0.764	0.463	0.476	0.783	0.353		
SE	0.722	0.651	0.382	0.394	0.461	0.609	

Notes. CF – cultural fusion; GB – genre blending; IC – innovation in composition; TI – technological innovation; IE – innovation in education; SA – sustainability awareness; SE – student engagement.

Table 4
Reliability and convergent validity of HOC.

	Loadings	CR	Cronbach's alpha	AVE
Hybrid musical genres		0.631	0.901	0.867
Cultural fusion	0.827			
Genre blending	0.788			
Innovation in composition	0.801			
Technological innovation	0.758			

internal consistency of the constructs. The CR values are all above 0.9 for hybrid musical genres, which far exceeds the recommended threshold of 0.7 and suggests an excellent level of reliability.

The AVE for hybrid musical genres stands at 0.631, comfortably above the minimum standard of 0.5, confirming good convergent validity. This indicates that a majority of the variance in the items is accounted for by their respective constructs, affirming that the constructs are well-defined and accurately measured.

Overall, these measures of reliability and convergent validity presented in Table 4 further bolster the methodological rigor of the study, ensuring that the constructs used are both reliable and valid.

The results from the partial least squares (PLS) analysis detailed in Table 5 provide robust support for the hypothesized effects of hybrid musical genres on innovation in education, sustainability awareness, and student engagement. The analysis shows strong and significant paths between these constructs, corroborating the theoretical framework developed for this study.

The direct effects show that hybrid musical genres have a strong influence on student engagement ($\beta = 0.549$, $p < 0.000$), innovation in education ($\beta = 0.488$, $p < 0.000$), and sustainability awareness ($\beta = 0.508$, $p < 0.000$), with all hypotheses (H1, H2, H4) being accepted. These findings indicate that hybrid musical genres play a critical role in enhancing educational outcomes, aligning with the literature that emphasizes the importance of integrating diverse musical influences to foster engagement and innovation in educational settings.

Table 5
Results of partial least square analysis.

	Path	B	t-value	*p*-value	R^2	decision
Direct effects						
H1	HMG ➔ SE	0.549***	7.46	0.000	0.481	Accept
H2	HMG ➔ IE	0.488***	8.314	0.000	0.445	Accept
H4	HMG ➔ SA	0.508***	7.672	0.000	0.342	Accept
H6	IE ➔ SA	0.447***	6.415	0.000		Accept
Mediation model (indirect effects)						
H3	HMG ➔ IE ➔ SE	0.239***	5.452	0.000		Accept
H5	HMG ➔ SA ➔ SE	0.217***	3.202	0.003		Accept
Serial mediation model (indirect effects)						
H7	HMG ➔ IE ➔ SA ➔ SE	0.201***	3.608	0.001		Accept

Notes.
*** Significant at $p < 0.05$ (1.96).

Furthermore, the model explains a substantial amount of variance in the dependent variables, with R^2 values of 0.481 for student engagement, 0.445 for innovation in education, and 0.342 for sustainability awareness. These high R^2 values demonstrate the significant explanatory power of hybrid musical genres in the context of educational outcomes.

The mediation model results also provide compelling evidence for the indirect effects hypothesized. The path from hybrid musical genres to student engagement through innovation in education (H3) is significant ($\beta = 0.239$, $p < 0.000$), as is the path from hybrid musical genres to student engagement through sustainability awareness (H5) ($\beta = 0.217$, $p = 0.003$). These results confirm the role of innovation in education and sustainability awareness as important mediators in the relationship between hybrid musical genres and student engagement.

Additionally, the serial mediation model, which includes hybrid musical genres influencing student engagement through the sequential mediation of innovation in education and sustainability awareness (H7), shows a significant effect ($\beta = 0.201$, $p = 0.001$). This finding supports the complex interplay between these constructs and highlights the sequential impact of hybrid musical genres on educational outcomes through multiple pathways.

Overall, these results not only validate the study's hypotheses but also underline the transformative potential of hybrid musical genres in enhancing educational processes and outcomes. The significant and positive effects observed suggest that educators and curriculum developers should consider incorporating hybrid musical genres into their teaching practices to foster a more engaging, innovative, and awareness-oriented learning environment.

4. Discussion

The study's investigation into the role of hybrid musical genres (HMGs) in fostering innovation in education, sustainability awareness, and student engagement provides empirical support for their significance in modern educational practices. The findings validate the hypothesized relationships and contribute to a deeper understanding of how music education can serve as a vehicle for broader pedagogical and societal outcomes.

The study confirms that HMGs have a significant positive impact on student engagement (H1), aligning with prior research suggesting that exposure to diverse musical forms enhances learning interest and participation (Chen & O'Neill, 2020). The results indicate that students engaged with hybrid musical elements reported higher levels of active participation and motivation, supporting the idea that integrating multiple cultural influences in music fosters a more immersive learning environment. This finding also resonates with constructivist learning theories, which emphasize experiential and participatory learning (Bada & Olusegun, 2015).

A key contribution of this study is the empirical validation of HMGs as catalysts for innovation in education (H2). The findings demonstrate that exposure to genre-blending and technologically integrated music encourages creative pedagogical approaches, which is consistent with previous research highlighting how music diversity stimulates critical thinking and novel instructional methods (Camlin & Lisboa, 2021; Jena et al., 2023). This suggests that educators incorporating HMGs into their curricula may be more inclined to experiment with innovative teaching methodologies, fostering a dynamic and interactive learning atmosphere.

The mediating effect of innovation in education on the relationship between HMGs and student engagement (H3) reinforces the idea that innovative educational practices serve as an essential mechanism through which HMGs enhance engagement. The results indicate that schools and institutions fostering music-based innovation experience

greater student involvement, reflecting research by Wilson (2022a, 2022b), who found that creative, music-integrated curricula enhance classroom participation. These findings suggest that merely introducing hybrid musical genres is not sufficient; rather, they must be embedded in innovative instructional strategies to maximize student engagement.

This study confirms that HMGs significantly enhance sustainability awareness (H4), aligning with previous literature suggesting that interdisciplinary and cultural approaches in education improve students' awareness of environmental and social issues (de Moya Martínez & Syroyid Syroyid, 2021; Guo et al., 2020). The results highlight that students exposed to hybrid music education were more likely to recognize the connections between cultural sustainability and ecological responsibility, reinforcing the role of arts-based education in fostering global consciousness. This supports the broader educational aim of integrating sustainability themes into artistic disciplines to encourage responsible citizenship.

The findings also establish that sustainability awareness mediates the impact of HMGs on student engagement (H5). This suggests that students become more engaged when their learning experiences resonate with real-world issues (Pacis & VanWynsberghe, 2020). Prior research has shown that sustainability-driven curricula enhance students' sense of purpose and motivation (Grant & Low-Choy, 2021), and the present study extends this notion by demonstrating that hybrid musical genres can serve as a medium for sustainability discourse in education.

A notable contribution of this research is the confirmation that innovation in education positively influences sustainability awareness (H6). Innovative teaching methods—such as technology-enhanced music composition and interdisciplinary coursework—expose students to sustainability themes in creative ways, reinforcing earlier findings that suggest educational innovation fosters a deeper understanding of global challenges (Ng et al., 2022). This underscores the potential of pedagogical creativity in promoting environmental awareness, particularly within music education.

The study's serial mediation model (H7) provides a more nuanced understanding of how HMGs impact student engagement through the sequential pathways of innovation in education and sustainability awareness. This finding aligns with experiential learning theories, which argue that real-world relevance and creativity drive student motivation (Acosta-Gonzaga & Ruiz-Ledesma, 2022). The cascading effect observed in this study suggests that hybrid musical genres do not directly enhance student engagement alone but must be embedded in a broader ecosystem of innovative teaching and sustainability discourse.

4.1. Theoretical and practical implications

The findings of this study have important theoretical and practical implications, highlighting the role of hybrid musical genres (HMGs) in advancing educational innovation, sustainability awareness, and student engagement.

4.2. Theoretical implications

This study contributes to the theoretical discourse on music education and interdisciplinary learning by demonstrating that HMGs serve as a mechanism for fostering innovation in education and sustainability awareness, ultimately enhancing student engagement. The research provides empirical validation for constructivist learning theories (Bada & Olusegun, 2015), which emphasize experiential and participatory learning, as well as socio-cultural theories (Panhwar et al., 2016) that highlight the impact of diverse cultural exposure on cognitive development and engagement.

By establishing innovation in education as a mediator between HMGs and engagement, this study builds upon existing literature suggesting that creative educational interventions stimulate student motivation and learning effectiveness (Wilson, 2022a, 2022b). Furthermore, the study extends prior work by demonstrating that sustainability awareness acts as a secondary mediator, reinforcing the idea that students engage more deeply when their education is contextually relevant and connected to real-world issues (Grant & Low-Choy, 2021).

The serial mediation model proposed in this study adds a new dimension to educational psychology research, illustrating that student engagement is not solely a direct outcome of innovative pedagogical tools, but is also shaped by sequential cognitive and motivational processes. These insights provide a stronger empirical foundation for future studies exploring how interdisciplinary approaches in education create multi-layered impacts on learning outcomes.

4.3. Practical implications

The study offers actionable insights for educators, curriculum developers, and policymakers seeking to enhance educational engagement through music-based innovations. The findings suggest that educators should incorporate hybrid musical genres into formal curricula to stimulate creativity, enhance engagement, and promote sustainability awareness. Music programs should encourage genre fusion, technological integration, and composition-based experimentation, fostering innovative learning experiences for students. Schools and universities should design interdisciplinary courses that blend music with environmental studies, technology, and social sciences, reinforcing critical thinking and real-world problem-solving skills. Teachers should use project-based learning and collaborative activities that integrate hybrid musical genres with sustainability topics, making education more immersive and relevant.

To effectively implement hybrid musical genres in education, teacher training programs should emphasize interdisciplinary teaching methods. Professional development initiatives should provide educators with theoretical and practical tools for integrating music-based innovation into diverse classroom settings. Policymakers should prioritize arts-based education as a core component of modern curricula, ensuring that hybrid musical genres are not limited to extracurricular activities but are embedded in formal educational frameworks. Funding should be allocated for technological resources in music education, enabling students to explore digital tools for hybrid musical composition.

The results also suggest that students are more engaged when they recognize the broader relevance of their education. Institutions should implement longitudinal studies and follow-up programs to ensure that sustainability awareness cultivated through hybrid musical genres translates into long-term behavioral change and civic engagement. By embedding music education within a broader interdisciplinary and socially relevant framework, educators and policymakers can enhance both the effectiveness and long-term impact of hybrid musical genres in educational settings.

4.4. Limitations and future research directions

While this study provides insightful findings, it also presents certain limitations that pave the way for future research.

One limitation is the reliance on self-reported data, which may introduce social desirability bias or subjective interpretation of survey items. Respondents might have provided answers they perceived as favorable rather than reflecting their actual experiences. To mitigate this, future research could integrate objective observational measures, such as teacher assessments or behavioral data, alongside self-reported responses to enhance validity and reliability. Additionally, qualitative methods, such as in-depth interviews or focus groups, could provide richer insights into students' and educators' experiences with hybrid musical genres.

Another limitation pertains to contextual constraints, as the study focuses on a specific educational and cultural setting, potentially limiting the generalizability of its findings. While respondents were drawn from multiple institutions, the results may not fully capture variations across different geographic, cultural, or institutional contexts.

Future research could expand the sample to diverse regions and educational systems, ensuring broader applicability of the findings. A cross-cultural comparative study would be particularly valuable in assessing how hybrid musical genres influence education across different learning environments.

Furthermore, this study provides a cross-sectional analysis, offering a snapshot of how hybrid musical genres impact student engagement, innovation in education, and sustainability awareness. However, longitudinal research is needed to evaluate the long-term effects of incorporating hybrid musical genres into educational programs. Tracking students over time could help assess whether these genres have a lasting impact on student motivation, academic performance, and sustainability consciousness.

Finally, while this study examines the role of hybrid musical genres in fostering educational innovation, further research is needed to explore specific teaching methodologies that optimize their effectiveness. Future studies could investigate which instructional strategies, classroom activities, or curriculum designs best facilitate engagement and learning when integrating hybrid musical genres. This could provide practical guidelines for educators and policymakers seeking to implement innovative arts-based learning approaches.

By addressing these limitations, future research can strengthen the theoretical foundation of hybrid musical genres in education and enhance their practical application in diverse learning environments.

5. Conclusion

In conclusion, this study highlights the significant role that hybrid musical genres can play in enhancing innovation in education, raising sustainability awareness, and boosting student engagement. By integrating diverse musical influences into educational settings, educators can foster a more dynamic and inclusive learning environment that not only engages students but also prepares them to address global challenges with creativity and critical thinking. The findings emphasize the potential of music as a powerful educational tool, suggesting that a greater focus on incorporating hybrid musical genres could transform educational practices and outcomes. Moving forward, it is essential for educational stakeholders to consider these insights in curriculum development and teaching strategies, aiming to harness the full potential of arts integration in shaping future generations.

CRediT authorship contribution statement

Zhang Zhongsheng: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Informed consent statement

All participants gave written consent to publish this work.

Institutional review board statement

The research ethics board at Zhengzhou University of Industrial Technology accepted the study. It was carried out strictly in accordance with ethical guidelines.

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Declaration of competing interest

There are no conflicts of interest among the authors.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2025.104851.

Data availability

Access to raw data is limited in compliance with ethical norms and privacy regulations.

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