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# AI INNOVATIONS AND MUSIC PSYCHOLOGY: THE ROLE IN DRIVING SUSTAINABLE MENTAL WELLNESS (SDG 3) AND QUALITY MUSIC EDUCATION (SDG 4) IN THE DIGITAL ERA

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## Abstract

Music is an elementary element of human life, deeply reflecting emotion, creativity, and social interaction. The digital age has brought about integration between music psychology and artificial intelligence (AI), revealing new dimensions in the analysis and generation of musical emotions. This article investigates the interdisciplinary dynamics among humans, music, technology, and emotion, with a particular focus on the role of AI as an affective co-creator, capable of interpreting physiological data (e.g., EEG, heart rate) and behavioural signals to generate personalised music experiences and to promote real-time emotional responsiveness.

The results of the knowledge synthesis revealed that AI has high potential to enhance adaptive learning and data-driven music. The synthesis of current scholarship indicates that AI holds substantial potential to advance adaptive music learning and data-driven music therapy. The application of this innovation plays a crucial role in achieving the Sustainable Development Goal (SDG 3: Good Health and Well-being) through expanding access to effective and equitable mental health services and supporting, SDG 4: Quality Education through the creation of adaptive learning systems that respond to all learners.

Critical challenges requiring nuanced consideration include AI music ethics, questions of authorship in human-AI co-creation, and the authenticity of machine-generated emotions. Key recommendations emphasize the development of AI models that are sensitive to users' cultural and

emotional contexts (cultural–emotional sensitivity) and the promotion of research on human–AI affective synergy to preserve a balance between technological innovation and core human values.

**Keywords:** Music psychology, artificial intelligence, emotion, music therapy, human–AI interaction, SDG 3, SDG 4, AI ethics

## INTRODUCTION

Music is a cultural code and emotional experience that has accompanied human being since ancient times. It functions as a universal language can communicate the most complex human emotions (Koelsch, 2014). Music is recognized as a powerful mechanism for modulating emotions, reducing stress, and enhancing cognitive functioning in psychological and neuroscientific perspectives, (Juslin & Sloboda, 2010). Musical perception represents an integration of physical, kinesthetics and auditory experiences, according to the concept of Embodied Music Cognition (Leman, 2007).

Transitioning to the era of artificial intelligence and co-creation. The advent of artificial intelligence (AI) has completely revolutionised music and psychology, from automated music composition with tools such as Magenta and AIVA to real-time analysis of listener emotions with Music Emotion Recognition (MER) (Briot, Hadjeres, & Pachet, 2020; Herremans, Chuan, & Chew, 2017). This phenomenon raises philosophical and psychological questions about the extent of human-machine co-creation. The 21st century is also an era characterized by profound and multifaceted transformations across technology, the environment, society, politics, and the economy. These dimensions are no longer developing independently but are increasingly interconnected, forming a global landscape that is highly dynamic and deeply interlinked. One of the key forces driving these changes is the relentless advancement of technology particularly digital technology and artificial intelligence (AI) which has become central to nearly every aspect of human life, fundamentally reshaping communication, work, learning, and everyday living. (Tayossyngyong, Bangbon, Naude, Zhang, Siribsanont, & Suwanchotnate, 2025).

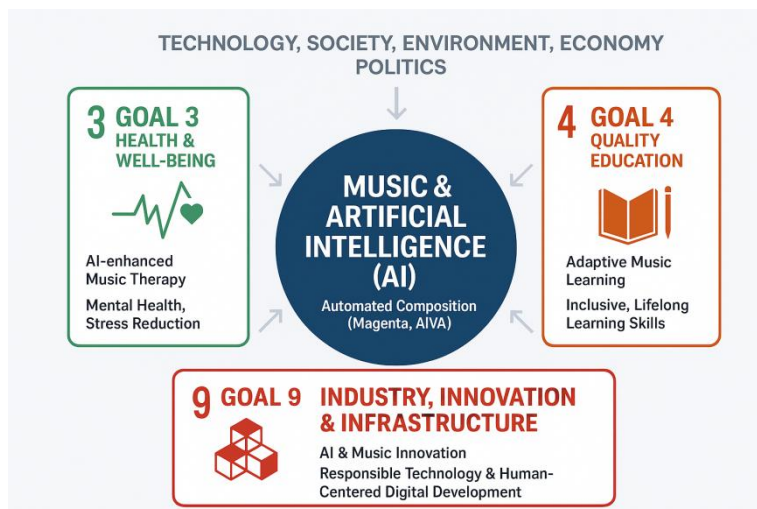


Figure 1: Interconnectedness of Music & AI with SDGs in the 21st Century Transformation

The context of the Sustainable Development Goals (SDGs) in music and technology shows that AI research and applications in music are closely aligned with the United Nations Sustainable Development Goals (SDGs), as shown below:

1. Goal 3: Health and well-being AI-enhanced music therapy can promote effective and low-cost mental health services, directly impacting Goal 3.4, which focuses on improving mental health and well-being.
2. Goal 4: Quality Education AI-powered adaptive learning systems enable inclusive and equitable music education by tailoring learning experiences to each learner, supporting Goal 4.4, which aims to develop the skills necessary for lifelong learning.
3. SDG 9: Industry, Innovation, and Infrastructure. AI and music innovation also contribute to SDG 9 by promoting responsible technological innovation, with music serving as a medium to foster human-centered, socially responsible digital development.

### Theoretical Framework

This theoretical framework is based on music psychology, particularly emotional mechanisms explained through models such as the BRECVEMA framework proposed by Juslin and Sloboda (2010), as well as neuroscientific foundations that emphasize the role of reward circuits and limbic system function in musical and emotional responses (Koelsch, 2014). Within this foundation, AI functions as a catalytic agent across three principal dimensions.

## 1. AI as an Emotional Data Interface

AI systems, particularly Music Emotion Recognition (MER), act as intermediaries in interpreting emotional data, using machine learning techniques to classify emotions from acoustic features, physiological signals (e.g., heart rate), or behavioral patterns (Tzafilkou et al., 2022). This capability allows for a deeper understanding of human emotional responses, overcoming the limitations of traditional experimental psychology and providing insights into different dimensions of emotional processing.

## 2. Dynamic Interaction, Co-Creation, and Adaptive Response

Generative AI models like MuseNet, powered by deep learning architectures, can co-create musical works of both structural and emotional complexity with human users (Briot et al., 2020). This leads to the concept of Human–AI Affective Synergy, where AI does not replace human creativity but rather acts as an extension of human cognition and emotion. This collaboration enables people to co-create musical expressions and gain a more systematic understanding of their own emotional states through neurophysiological and behavioral data. (Leman, 2007).

## Theoretical Framework:

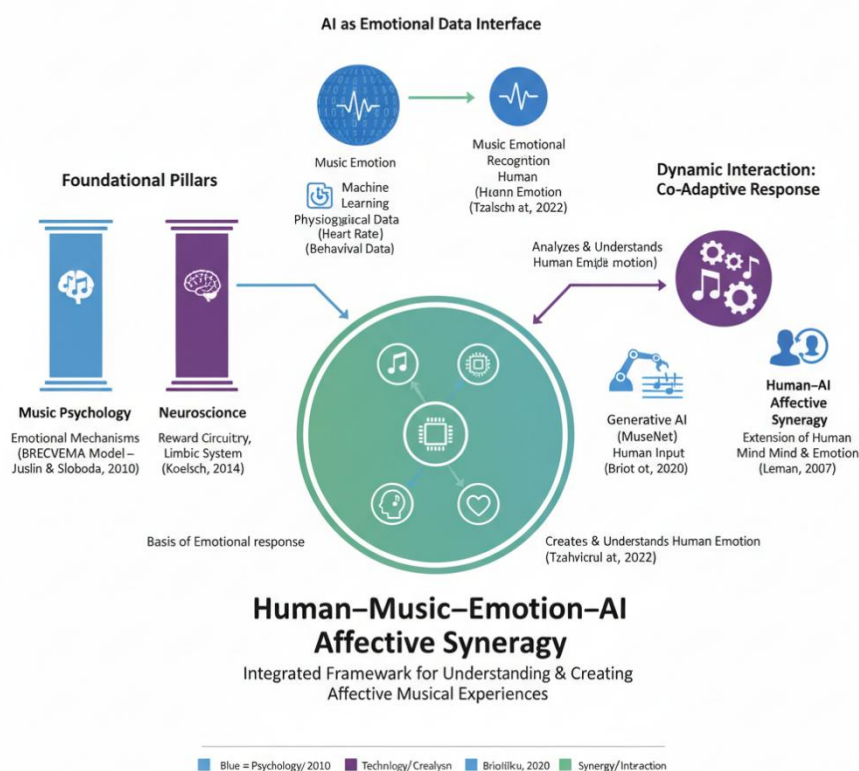


Figure 2: Theoretical Framework

## Applications in Therapy and Learning for Sustainability

AI integration has significantly advanced the applications of music in health and education, and has effectively contributed to the achievement of the relevant Sustainable Development Goals (SDGs).

### 1. AI-Enhanced Music Therapy: Expanding Mental Health Support (SDG 3)

1.1 Empirical Impact of Music Therapy Music therapy has been widely recognized as an effective treatment method for managing depression, anxiety, and pain (Bradt & Dileo, 2014). The application of artificial intelligence (AI) to these therapies has led to the development of biofeedback-based AI-powered music therapy, which improves both accuracy and responsiveness.

1.2 Mechanisms and Emotional Responses. AI systems analyze physiological signals such as electroencephalography (EEG) and heart rate variability (HRV) to assess stress levels and emotional states (Fitzpatrick et al., 2017). From this information, the AI dynamically adjusts musical elements such as tempo, key, and tone to reduce cortisol levels and stimulate the limbic system to induce relaxation. (Wang & Jia, 2021).

This adaptive and individualized therapy model directly supports Sustainable Development Goal (SDG) 3.4, which focuses on improving mental health and well-being. Furthermore, its implementation through mobile applications and digital platforms helps expand access to high-quality, affordable mental health services for underserved populations.

2. Artificial Intelligence in Quality Music Education (SDG 4). AI has transformed music learning by enabling adaptive learning systems that respond to learners' developmental progress and emotional states.

2.1 Adaptive learning Platforms like Yousician use AI to analyze pitch accuracy and rhythm accuracy in real time, providing immediate and targeted feedback (Herremans et al., 2017). These systems act as AI tutors, adjusting the difficulty level of lessons to each learner's progress and ability.

2.2 Advancing Sustainable Development Goal 4, the application of affective computing in music education (Picard, 2000) enables AI to detect learners' emotions and recommend practice pieces that increase motivation and emotional engagement. This emotionally responsive and personalized learning environment supports equitable and inclusive quality education, which directly impacts Sustainable Development Goal 4.4, which emphasizes the development of relevant skills for lifelong learning. Policy Alignment and Future Directions According to Thailand's National Education Plan (2017–2036), SDG 4 is explicitly incorporated, reflecting a strong political commitment. The plan emphasizes the importance of lifelong learning, the development of skills for the future workforce, and inclusive education for all. (Lertatthakornkit et al., 2025)

### **Ethical, Innovative, and Humanistic Challenges**

Despite the incredible potential of AI, integrating technological systems with the deep emotional dimensions of music presents significant ethical and humanitarian challenges.

#### **1. Emotional Authenticity and Intellectual Property**

A fundamental question emerges: Where does “authentic emotion” reside? AI still cannot fully replicate or comprehend the intrinsic emotional meaning embedded in human experiences (Panksepp, 1995). This gap has sparked ethical debates concerning **authorship**, **creative ownership**, and **emotional data privacy**—the rights and protections associated with users' emotionally infused data (Herremans et al., 2017; Huang & Sturm, 2021). Maintaining an equilibrium between genuine human emotionality and machine logic is therefore central to the development of an evolving framework for **AI Music Ethics**.

#### **2. Cultural Sensitivity**

Cultural context shapes how individuals perceive and interpret music and emotion. AI systems trained primarily on Western datasets may fail to accurately recognize or respond to emotional expressions deeply rooted in non-Western musical traditions. Such biases can lead to ineffective or culturally inappropriate therapeutic or learning outcomes. Therefore, future AI systems need to cultivate a deeper understanding of humanity's musical and emotional language to ensure respect and alignment with diverse cultural identities.

## **CONCLUSION AND DISCUSSION**

This synthesis confirms the emergence of a new ecosystem where artificial intelligence (AI), music, and human psychology are integrated and inseparable. The merging of these disciplines not only offers technological applications but also opens new dimensions in understanding and managing human emotional experience through musical expression.

Findings from the analysis indicate that AI has transformed music from a traditional affective stimulus into a “data-driven affective interface.” By using Affective Computing techniques, AI can interpret subtle physiological indicators such as electroencephalogram (EEG) and heart rate variability (HRV), providing a subtle understanding of human psychological and physiological states (Tzafilkou et al., 2022; Picard, 2000).

In the context of music therapy, AI acts as an autonomous mood regulator, dynamically adjusting musical parameters (e.g., rhythm, tone, and volume) in real time to induce physiological changes consistent with therapeutic goals, such as reducing cortisol levels and promoting emotional stability (Fitzpatrick et al., 2017; Wang & Jia, 2021). This confirms that music in the AI era bridges neuroception (the brain's non-conscious evaluation of stimuli) with algorithmic response, forming a core mechanism for advancing sustainable mental well-being in alignment with SDG 3: Good Health and Well-being.

From a creative standpoint, Generative AI serves as a cognitive extension, enabling humans to explore complex musical-emotional landscapes with unprecedented speed and depth (Briot et al., 2020). This interaction raises the psychological question of how meaningful and authentic the emotional experiences created by co-creating with machines are in terms of qualia (emotional value) and human experience (Huang & Sturm, 2021).

**Philosophical Limitations and Challenges to Sustainability** Despite the progress, this study continues to highlight the value gap that remains between the logical operations of machines and the emotional depth of human experience (Panksepp, 1995). Future developments must prioritize AI's musical ethics and cultural and emotional sensitivity to ensure that AI-assisted therapeutic and educational approaches promote learning equity (SDG 4) without creating cultural homogeneity or inequities in access. Furthermore, innovations must preserve, rather than diminish, the integrity and uniqueness of human musical and emotional experience.

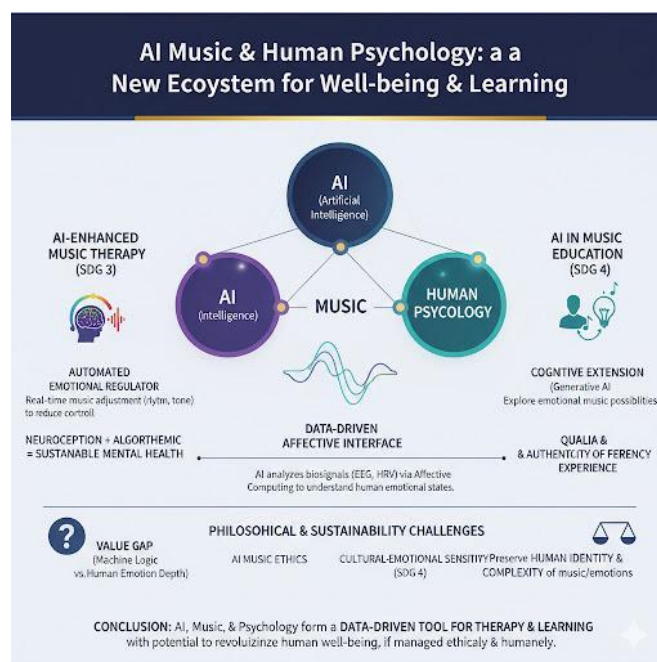


Figure 2: AI, Music, & Human Psychology: A New Ecosystem for Well-being & Learning

In summary, the integration of artificial intelligence, music, and psychology has created powerful data-driven tools for therapy and learning that have the potential to revolutionize human well-being. However, these benefits will only be fully realized if emerging ethical challenges are addressed in a thoughtful, human-centered, and culturally responsive manner.

### Recommendations for Advancing the Sustainable Development Goals (SDGs)

1. Recommendations for researchers and technology developers (focusing on SDGs 3 and 9) should focus on developing AI that takes into account the emotional, cultural, and individual context of users to expand access to quality mental health services (SDG 3.4), with an emphasis on low-cost and easily accessible tools in remote areas to promote sustainable innovation (SDG 9.5).
2. Recommendations for teachers and educational institutions (focusing on Goal 4) AI should be integrated into music and arts teaching processes to create inclusive and equitable adaptive learning systems (Goal 4.4) that provide all learners with the opportunity to develop skills and emotional understanding through music.
3. Recommendations for future research (focusing on SDGs 3 and 16) should focus on research into the musical ethics of AI to enable responsible innovation and to ensure that the use of emotional data does not infringe on privacy, which is fundamental to health and well-being (SDGs 3) and the creation of effective and accountable institutions (SDGs 16).

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