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The Application Innovation and Development Trends of Artificial Intelligence Empowering Music Classroom Education in Chinese Universities

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Introduction

The rapid development of artificial intelligence has brought revolutionary changes to the field of education. Particularly in university music education, AI technologies are being widely applied in the development of intelligent teaching tools, the realization of personalized learning, the integration of virtual reality technologies, and the automation of teaching evaluation systems. This fusion of technology and art not only expands the boundaries of music education but also provides a fresh perspective for instructional design. Nevertheless, the application of AI in music education remains in its exploratory phase, facing multiple challenges such as the difficulty of precisely aligning teaching objectives with technological tools and the insufficient cultivation of students' creativity and emotional expression. Therefore, from the perspective of instructional design in university music classrooms, a systematic analysis of the current applications and issues of AI in music education is of significant importance for further promoting its effective integration.

I. Definition of Related Concepts and Framework

a) Related Concepts of Music Classroom Education

Music classroom education is a vital component of higher education in music, aiming to cultivate students' theoretical knowledge, performance skills, music appreciation abilities, and creative capabilities through systematic curriculum design and teaching methods (Gao, 2020). It is characterized by its professionalism, practicality, interactivity, and integration of technology (Li & Yang, 2021). The curriculum encompasses specialized content such as music theory, performance techniques, composition, and arrangement, while also emphasizing the enhancement of students' musical literacy through practical activities like performances, choir, and composition (Zhao, 2018). Additionally, classroom teaching focuses on teacher-student interaction, collaborative performances, and improvisation to unlock students' musical potential (Wang & Huang, 2022). With technological advancements, emerging technologies such as digital audio, virtual reality (VR), and artificial intelligence (AI) are gradually being integrated into university music classrooms, driving innovation and development in teaching models (Liu, 2021). Research has indicated that AI and VR technologies in particular can create immersive learning environments, offering students unique opportunities to engage with music in ways that were previously not possible (Xu, 2022). These technologies offer the potential for personalized learning experiences, adapting to the individual pace and style of each student (Zhang, 2023). As such, the integration of emerging technologies is transforming traditional music education into more dynamic and interactive experiences.

b) Related Concepts of Artificial Intelligence

Artificial Intelligence (AI) is a technology that uses computers to simulate and extend human intelligence, encompassing fields such as machine learning, deep learning, natural language processing, and computer vision. In the field of education, AI applications are primarily reflected in intelligent tutoring systems, automated assessment and feedback, intelligent content generation, and immersive learning environments. Through big data analysis, AI can provide personalized learning plans to improve learning efficiency, while offering objective feedback for performances, compositions, and music theory exams through precise evaluation. Furthermore, AI can automatically generate practice pieces, compositional inspiration, and accompaniments to enhance creative

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abilities. Combined with VR/AR technologies, AI can create virtual music classrooms, enabling students to experience music performance immersively and optimize learning outcomes.

c) Related Concepts of AI-Empowered Music Classroom Education

AI-empowered music classroom education refers to the use of AI technologies to optimize teaching models in university music classrooms, enhancing teaching quality and learning experiences to make classrooms more intelligent, personalized, and interactive (Zhang & Li, 2022). Its core components include intelligent accompaniment systems, personalized learning, automated scoring, AI-assisted composition, and virtual teaching (Chen, 2023). AI can adjust accompaniments in real-time based on students' performances, making practice smoother and more expressive. For instance, systems such as smart accompaniment programs can respond dynamically to students' playing, altering musical backing to match tempo, key, and phrasing, allowing for more engaging and expressive practice (Wang & Lin, 2021). AI can also analyze students' learning habits, recommend suitable practice pieces and course content, and provide targeted improvement suggestions. Studies have shown that personalized learning pathways, powered by AI, can help to identify areas where students need more attention and offer customized instructional content (Xu, 2020). Additionally, AI systems can quantitatively evaluate performances by recognizing parameters such as pitch, rhythm, and dynamics, offering detailed feedback (Liu & Wang, 2021). This can help students track their progress over time, providing insights into their strengths and areas for improvement. Composition tools powered by AI can assist students in melody creation, harmony writing, and style simulation, improving creative efficiency and expressiveness (Sun, 2021). By analyzing vast datasets of musical works, AI can suggest harmonic progressions, melodic ideas, and stylistic nuances, thus enriching the creative process. Leveraging AI technologies, virtual teaching and remote education models can be developed, enabling cross-regional sharing of high-quality music education resources and benefiting more students (Zhao & Li, 2022). This allows for the democratization of music education, where students from diverse geographical locations can access top-tier instructional content and expert guidance.

II. Analysis of the Current Application of AI-Empowered Music Classroom Education in Chinese Universities

The rapid development of artificial intelligence technology has brought multifaceted innovations and enhancements to university music classrooms. Through the introduction of intelligent teaching tools, personalized learning experiences, virtual reality and augmented reality (VR/AR) technologies, and automated teaching evaluation systems, AI is driving the modernization and transformation of music education (Gao & Zhang, 2022).

a) Development of Intelligent Teaching Tools

With the rapid advancement of AI technology, the application of intelligent teaching tools in university music classrooms has shown a trend of diversification, providing efficient support and innovative methods for music education. These tools demonstrate significant potential in music composition, instrumental performance, and internationalized courses, laying a solid foundation for the modernization of university music education (Wang & Chen, 2021).

In music composition courses, intelligent composition and arrangement tools (such as AIVA and MuseNet) offer students a rich platform for creative practice. By leveraging deep learning on vast music databases, these tools can generate musical works spanning various genres, including pop, classical, and jazz (Liu & Zhang, 2020). For example, in a music composition course at a university, instructors use AIVA to demonstrate the process of generating Mozart-style music and then ask students to design variations and arrangements based on the generated segments. This approach deepens students' understanding of classical music composition techniques. Meanwhile, MuseNet's deep learning capabilities support the hybrid generation of multiple instruments and styles, enabling students to experiment with combining Baroque elements and electronic music, thereby inspiring cross-genre creativity (Xu & Li, 2021).

In instrumental courses, intelligent teaching tools (such as AI-equipped pianos) provide real-time feedback to support personalized learning. These tools use high-precision sensors and algorithms to instantly capture issues with pitch, rhythm, and fingering during student performances (Zhao, 2021). For instance, in a piano course at a music conservatory, Yamaha Disklavier, an AI-powered piano, is used to help students practice Chopin's Études. The AI system can annotate incorrect notes in real time and offer fingering suggestions based on professional performance standards. Moreover, the system generates progress reports based on students' practice data, helping instructors understand individual learning progress and develop more targeted teaching plans (Sun & Zhang, 2022). Additionally, AI tools support multilingual interfaces, assisting international students in overcoming language barriers and comprehending complex music theory. For example, a non-native English-speaking student used an AI translation tool to study English analysis materials of Beethoven's

"Appassionata Sonata." Through semantic parsing and graphical presentation, the system not only improved learning efficiency but also deepened the student's understanding of the musical work (Wang, 2020).

Voice recognition technology has also been widely adopted in university music classrooms, particularly in choir and conducting courses. For example, in choir rehearsals, AI voice recognition tools can analyze students' pronunciation accuracy and pitch, identify intonation deviations within the choir, and provide real-time audio correction suggestions (Li, 2022). In a conducting course at a university, instructors use AI systems to allow students to observe the relationship between conducting gestures and ensemble sound effects in real time, helping them intuitively understand how subtle adjustments in conducting movements impact overall musical expression (Zhao & Huang, 2023).

b) Realization of Personalized Learning Experience

The introduction of artificial intelligence (AI) technology in university music education has made personalized learning possible. Through big data analysis and intelligent algorithms, AI can provide differentiated learning support based on the individual needs of students, significantly enhancing teaching effectiveness and the learning experience (Liu & Wang, 2021). Its application in music theory, music history, and practical courses has become a key force in advancing the modernization of music education (Chen & Li, 2022). Research has demonstrated that AI-driven personalization can address students' unique learning paces, providing more efficient and targeted instructional strategies (Wang, 2021). This personalized learning approach not only helps students learn more effectively but also increases engagement and motivation by tailoring the educational experience to their specific needs (Zhang, 2020).

In music theory classes, AI systems can track students' learning progress in real-time and accurately identify their weaknesses. For example, in a harmony analysis course, a university has adopted an intelligent learning platform that monitors the error rate of students in harmony function identification and key recognition (Li, 2022). For students who frequently make mistakes, the system automatically generates personalized exercises, such as chord connection practice in specific keys, and uses interactive prompts to help students understand complex harmonic progressions. This data-driven teaching approach effectively improves students' mastery of music theory and significantly reduces knowledge gaps caused by overly standardized teaching content (Xu & Zhao, 2021). Research indicates that such AI-based systems are highly effective in reinforcing theoretical concepts and helping students bridge gaps in their understanding by offering tailored practice sessions (Wang & Huang, 2021).

In music history courses, AI technology provides strong support for personalized content recommendations. For instance, AI systems can customize and push relevant academic articles, sheet music, and multimedia resources based on students' interests (Sun & Liu, 2022). For a student interested in Beethoven's late works, the system would recommend sheet music analysis of *Symphony No. 9*, authoritative academic papers, and high-definition video recordings of performances by the Berlin Philharmonic Orchestra. This tailored content not only meets the student's need for in-depth research on specific composers or historical periods but also stimulates their interest and enthusiasm for exploring music history (Zhang & Li, 2020). Personalized content delivery has been shown to significantly enhance student engagement in music history courses by providing a richer and more relevant learning experience (Gao, 2022). AI's ability to deliver dynamic, context-specific content ensures that students engage more deeply with the subject matter, promoting sustained interest and curiosity.

Furthermore, interactive learning platforms combining AI with multimedia technology offer a richer, immersive experience for practical courses. For example, in conducting courses, virtual conducting tools have become a typical case of AI-supported personalized teaching (Xu, 2021). One university has introduced an AI virtual conducting system that allows students to practice conducting skills in response to a virtual orchestra. The system provides real-time feedback on whether the student's conducting movements are accurate, such as whether the beats are clear, the tempo is consistent, and the emotional expression is sufficient. For beginner conductors, the system can also adjust the complexity of the virtual orchestra to match their learning stage, helping them gradually improve their conducting skills (Wang & Li, 2022). Research has shown that the use of such virtual environments significantly enhances skill acquisition by offering immediate corrective feedback and personalized adjustments (Li & Zhang, 2020). This immersive experience greatly enhances students' engagement and skill development, with AI enabling a more dynamic and adaptive learning environment.

Meanwhile, AI technology also offers scientific support for students' learning plans. Some music colleges have begun using intelligent learning assistants to create personalized study plans based on students' academic performance, areas of interest, and course requirements. These plans include not only daily course arrangements but also recommendations for extra-curricular resources and the setting of intermediate goals, helping students efficiently complete their learning tasks (Chen, 2021). Research on intelligent learning assistants in music education has shown that these systems help students remain on track with their academic goals, facilitating a more organized and

effective learning process (Zhao & Sun, 2022). By offering individualized support, AI-powered assistants guide students through their courses, recommend relevant materials, and help them stay focused on their studies.

c) *Integration of Virtual Reality and Augmented Reality Technologies*

The integration of Virtual Reality (VR) and Augmented Reality (AR) technologies into university music education has injected new vitality into teaching. These technologies, through immersive and interactive experiences, not only enrich the content but also provide students with a more intuitive and vivid way of learning (Wang & Li, 2022). They have shown great potential, particularly in music appreciation, music culture courses, and music education major teaching scenarios (Zhao & Zhang, 2021). Research has indicated that VR and AR technologies can create highly engaging and effective learning environments that enhance student understanding by offering novel, immersive experiences that traditional methods cannot match (Xu, 2021).

In music appreciation courses, VR technology offers students an immersive learning experience. By wearing VR devices, students can "enter" a virtual concert hall and experience the atmosphere of a performance by world-class orchestras (Sun & Liu, 2022). For example, students can experience a live performance by the Berlin Philharmonic Orchestra through VR, observing the interaction between the conductor and the orchestra, and feeling the coordination and balance between different sections. Furthermore, VR can simulate the acoustic effects of different concert halls, allowing students to understand how architectural acoustic design impacts musical performance, such as the reverberation characteristics of the Vienna Golden Hall or the sound distribution in the Sydney Opera House (Wang, 2020). This multisensory immersive experience helps students not only appreciate music but also gain knowledge about the acoustic layout and performance environment design of concert halls, compensating for the shortcomings of traditional classroom descriptions with text and images (Chen & Zhang, 2021). Studies have shown that VR's ability to provide an experiential understanding of music performance enhances students' appreciation and knowledge of music history and acoustics (Li & Wang, 2020).

In music culture courses, AR technology uses dynamic visualization methods to vividly present the history and cultural contexts of music (Zhao, 2021). For example, when teaching about medieval music, instructors can use AR technology to recreate the orchestra setup and ceremonial scenes in medieval churches. Students can observe the shapes and structures of ancient musical instruments (such as the harp, vielle, and organ) used during that period and virtually experience their unique sound and expressive qualities. This time- and space-crossing teaching method allows students to more intuitively understand the deep connections between music and its historical and cultural background (Li, 2022). In Chinese traditional music courses, AR can also recreate the performance scenes of ancient court music, helping students appreciate the ceremonial and artistic aspects of ancient music and dance, deepening their understanding of Chinese music culture (Liu & Zhang, 2021). Research has demonstrated that AR's dynamic visualization enhances students' understanding of music's cultural significance by providing a more tangible and engaging experience (Chen & Zhao, 2021).

In music education professional courses, AR technology offers new tools for the study and research of teaching methods. For example, AR technology can dynamically demonstrate teaching scenes, such as simulating student learning behaviors in a primary school music class, helping future teachers observe and analyze the effectiveness of different teaching methods (Sun & Li, 2022). In addition, AR can recreate classic music teaching cases, such as Orff or Kodály methods, in actual classroom settings, allowing pre-service teachers to more intuitively grasp the practical application of these teaching theories. This technological application not only enhances their understanding of teaching theory but also strengthens their future abilities in teaching design and classroom management (Zhao, 2021). Research has shown that AR's ability to simulate classroom settings and teaching strategies greatly contributes to the development of effective teaching methods and classroom management skills for future educators (Li & Xu, 2021).

Furthermore, VR and AR technologies offer more possibilities for practical courses. For example, in conducting courses, VR technology can simulate real orchestra rehearsal scenes. Students can practice conducting in a virtual environment, observing the orchestra's real-time responses to their gestures, and experiencing how changes in tempo, dynamics, and expression impact musical performance (Zhang & Liu, 2020). In ensemble courses, AR technology can overlay real-time feedback systems, marking subtle issues in pitch, rhythm, and dynamics during performance, helping students quickly identify and correct deficiencies in their playing (Chen & Zhang, 2021). Studies have highlighted that VR and AR technologies in practical music courses help improve students' performance skills by providing immediate, targeted feedback and by allowing them to practice in highly realistic environments (Xu & Sun, 2020). This immersive approach to teaching enhances students' practical learning experience and aids them in mastering complex musical skills.

d) Optimization of Teaching Evaluation in Music Classes through Artificial Intelligence

The introduction of artificial intelligence (AI) technology in university music classrooms has significantly improved the efficiency and fairness of teaching assessments. Unlike traditional evaluation methods, which heavily rely on the subjective judgment of teachers, AI-driven systems provide more precise, multi-dimensional, and scientific tools for assessing music education. AI has demonstrated its unique advantages, particularly in instrumental courses, conducting courses, and music education programs (Gong & Li, 2020; Liu & Zhao, 2021). Several studies have highlighted how AI enhances objectivity and accuracy in assessments by offering data-driven evaluations that are not influenced by human biases (Chen & Xu, 2020).

First, in the final exams of instrumental courses, AI evaluation systems offer multi-dimensional assessments of students' performance in real-time. These systems use high-precision audio capture and algorithmic analysis to cover core aspects such as pitch accuracy, rhythm, dynamics, and emotional expression (Zhang & Li, 2022). For example, in a piano exam at a certain university, the AI system analyzes a student's performance of Chopin's Etude, not only detecting pitch and rhythmic errors but also quantifying the student's dynamic contrasts and emotional expression, generating detailed feedback reports. This evaluation method effectively reduces the influence of subjective factors in grading and provides students with more targeted improvement suggestions (Liu & Wang, 2021). Research supports that AI in instrumental assessments allows for more consistent and objective evaluations, which improves feedback quality and accelerates students' learning (Liu et al., 2021).

Next, in conducting courses, the application of AI technology significantly enhances the precision and interactivity of assessments. By capturing students' body movements and analyzing the accuracy of conducting gestures, AI systems can assess in real-time whether the student's conducting rhythm is clear, their gestures conform to standard techniques, and their emotional expression is appropriate (Zhao, 2022). For example, a university uses an AI conducting teaching system where students practice with a virtual orchestra, and the system instantly provides feedback on the orchestra's synchronization and its coordination with the conducting gestures. This dynamic assessment approach allows students to quickly identify areas for improvement, refine their conducting techniques, and significantly enhance learning outcomes in class (Xu & Sun, 2021). Studies have demonstrated that the integration of AI in conducting courses has made assessments more dynamic and interactive, leading to improved learning outcomes by providing timely feedback and promoting self-correction (Chen & Liu, 2022).

In music education courses, AI evaluation systems provide essential support for the development of future teachers' instructional abilities by recording and analyzing students' classroom performances over time (Zhang & Zhao, 2021). For example, in a music pedagogy course at a certain university, the AI system records and analyzes the music teaching plans designed and implemented by students, examining aspects such as the organization of content, allocation of class time, and the effectiveness of teacher-student interactions. The system can quantify various stages of the teaching activities and, through comparative analysis of different students' teaching designs, offer scientifically based improvement suggestions. Such data-driven support helps students identify weak areas in their teaching skills and provides empirical evidence for teachers to summarize and refine their teaching methods (Sun & Li, 2022). Research has shown that AI can provide valuable insights into teaching performance and improve instructional effectiveness by offering detailed, objective assessments (Liu et al., 2021).

More importantly, AI's teaching evaluation function also supports multi-dimensional, comprehend-sive assessments. For instance, the system can integrate data on students' learning progress, class participation, and long-term practical performance to create more personalized learning and development plans (Zhao & Chen, 2021). This data-driven evaluation approach not only enhances the fairness and efficiency of assessments but also promotes students' independent learning and overall development (Wang & Li, 2021). Studies have emphasized the importance of AI-driven, holistic evaluation systems in fostering a more comprehensive approach to student development by incorporating various aspects of their performance and progress over time (Xu & Zhang, 2020). This kind of multi-dimensional evaluation helps guide students in a more personalized direction, allowing them to focus on areas where they need improvement while supporting their overall growth in music education.

III. Technical Limitations and Instability

Although the rapid development of artificial intelligence (AI) technology has brought numerous advantages to music education in universities, its practical application still faces significant technical limitations and stability issues. These problems can negatively affect the teaching outcomes in various educational settings. Literature on AI in education (Li, 2020; Zhang & Wang, 2021) highlights these challenges, pointing to the difficulty of fully integrating AI in educational systems without addressing these core issues.

Firstly, intelligent composition and arrangement tools, while able to generate diverse musical works based on big data, often lack the originality and emotional depth found in artistic creation. This makes AI-generated music more like a replication or arrangement of existing styles, failing to convey the pursuit of ideological expression and emotional resonance that is central to music composition (Wu, 2021). Although AI can be an effective teaching aid, especially for generating basic musical forms or demonstrating compositional techniques (Zhao & Li, 2022), its inability to replicate human creativity and emotional nuance remains a significant limitation in courses designed to cultivate students' creativity and artistic perception (Liu & Xu, 2021). Studies have noted that while AI tools can assist students by providing structure and inspiration, the absence of true creativity in the generation of music might stifle the artistic expression and innovative thinking essential for student development in music composition (Chen, 2020).

Secondly, the application of speech recognition and real-time feedback technologies in music teaching also faces technical challenges. For instance, these systems may perform well when applied to the performance of a single instrument, but in more complex teaching environments, such as group ensemble classes, AI often struggles to accurately distinguish the details of different instruments' performances and may even confuse the performers. This kind of misjudgment not only disrupts the teacher's ability to assess but also lowers students' trust in AI-assisted teaching (Liang & Zhang, 2020). Additionally, as noted by Sun et al. (2021), the reliability of AI systems in differentiating nuanced aspects of multiple simultaneous performances in ensemble settings remains a critical challenge, as AI often cannot fully replicate the sensitivity of a human instructor's ear. Moreover, the real-time feedback function may fail to provide precise guidance when processing fast playing or complex rhythms due to computing delays, which can impact the flow of teaching. These delays are particularly detrimental in fast-paced or intricate musical pieces, where immediate feedback is crucial for correcting students' mistakes and enhancing their performance (Xu & Zhao, 2021).

Moreover, the smooth operation of AI systems heavily relies on stable hardware and network environments, which presents additional challenges in regions with limited educational resources (Siau & Wang, 2021) For instance, high-performance computing devices and high-speed networks are essential for ensuring the proper functioning of AI tools, but in underdeveloped areas or schools with insufficient funding, such infrastructure is often lacking, directly limiting the promotion and application of AI technology in education (Ning & Zhang, 2019).

Furthermore, the application of AI technology in music education is still constrained by the limitations of algorithms (Wu & Li, 2020). For example, the accuracy of emotional analysis and style recognition is closely related to the quality of the training data used in the algorithms (Lee & Choi, 2021). However, many AI tools' training datasets may be too narrow or biased toward specific styles, making it difficult to meet the diverse needs of global music education. In addition, some AI systems lack dynamic learning capabilities, preventing them from continuously optimizing based on students' feedback or progress, which limits their adaptability in long-term teaching practices.

a) Educational Equity and Resource Allocation Issues

The introduction of artificial intelligence (AI) technology has brought cutting-edge teaching tools and methods to music education. However, the high costs associated with software and hardware investment have become a major obstacle for many universities, especially those with weaker economic conditions, in popularizing related technologies (Zhao, 2022). For instance, the procurement of AI equipment such as smart pianos, VR devices, and advanced music arrangement software, as well as the costs of maintaining and upgrading these systems, represents a significant financial burden for universities with tight budgets (Liang & Sun, 2020). Furthermore, the deployment of these technologies requires supporting high-performance computing devices and stable network infrastructure, which are not always available in certain regions or institutions, further limiting the promotion of AI technology (Xie, 2022).

This imbalance in resource allocation may exacerbate issues of educational equity, leading to a widening gap in music education quality between different regions and institutions. Universities in economically developed areas can quickly introduce advanced AI technologies, providing students with high-quality learning resources and innovative learning experiences. In contrast, students in economically disadvantaged regions may miss the opportunity to access and use advanced teaching tools due to a lack of resources, putting them at a disadvantage in terms of professional skills and employability. According to Lee et al. (2021), "the digital divide in education not only affects immediate learning outcomes but also has long-term implications for career opportunities and social mobility" (p.12). This unequal distribution of technological resources could worsen the regional disparity and imbalance in the distribution of resources in music education, as highlighted by Brown (2019), who argues that "without equitable access to technological advancements, the gap between privileged and underprivileged institutions will continue to grow, perpetuating cycles of inequality" (p. 78).

Moreover, the effective integration of AI technology does not solely depend on the equipment itself, but also requires comprehensive policy support and a well-planned implementation strategy. As emphasized by Zhang and Liu (2022), "the successful adoption of AI in education hinges on robust policy frameworks and strategic planning, rather than mere technological acquisition" (p.34). However, some universities lack clear guidelines and systematic policy frameworks when introducing AI teaching tools. For example, certain institutions have not conducted in-depth research on the goals and methods of AI education, causing the technology to be applied only on a superficial level and preventing it from being truly integrated into teaching practices. According to Wang et al. (2021), "without a clear pedagogical vision and alignment with institutional goals, AI tools risk becoming underutilized or misapplied, failing to deliver their intended educational benefits" (p. 89). At the same time, the distribution of teaching resources within universities may also be uneven, with some departments or courses receiving more technological support while the educational needs of other areas are neglected. This further hinders the widespread promotion and popularization of AI technology, as noted by Chen (2020), who argues that "resource allocation disparities within institutions can create silos of innovation, leaving certain disciplines or programs marginalized in the adoption of advanced technologies" (p. 56).

b) Inadequacy of Teaching Content Adaptation

The effective application of artificial intelligence (AI) in university music classrooms must be closely aligned with course objectives and teaching content. However, many current AI tools are designed with a focus on generality and utility, making it difficult to meet the diverse and personalized course needs of music education. As noted by Thompson and Davis (2021), "AI tools often prioritize scalability over specificity, which can lead to a mismatch between technological capabilities and the nuanced demands of specialized fields like music education" (p. 23). This issue of poor adaptability is especially evident in specific teaching scenarios.

Firstly, existing intelligent instrument teaching tools are more suited for individualized practice rather than group teaching. These tools typically focus on providing feedback to individual students, including corrections for pitch, rhythm, and fingering. However, in university music classrooms, especially in group collaboration or ensemble courses, teaching needs are often more complex. Teachers need to focus on the coordination between multiple students, the overall sound balance, and the emotional expression of the performance. As highlighted by Martinez and Kim (2022), "AI tools currently lack the capacity to address the dynamic and interactive nature of group music instruction, which requires real-time adaptation to collective performance and interpersonal dynamics" (p. 67). This limitation makes the application of AI tools in classroom settings appear narrow and ineffective in improving the efficiency and quality of collective teaching.

Secondly, AI-generated music works or analysis reports tend to rely heavily on algorithmic logic, often overlooking the humanistic thinking and emotional expression that are intrinsic to music education. For example, in music composition courses, students need to express their thoughts and emotions through their creations. While AI-generated compositions may be technically flawless, they may lack the uniqueness and depth that should be present in artistic works. This contradicts the core objective of music education, which is to cultivate students' creativity and emotional resonance abilities. According to Bennett (2020), "AI-generated art risks prioritizing technical precision over emotional depth, which undermines the essence of artistic expression and creativity" (p. 45). Similarly, in music analysis courses, AI-generated analysis reports typically focus on data and patterns, neglecting an in-depth discussion of the music's background, historical context, and cultural value. This fails to meet the demands of music education for developing students' comprehensive literacy, as emphasized by Green and Patel (2021), who argue that "music education must transcend technical analysis to encompass cultural, historical, and emotional dimensions, which AI tools currently struggle to address" (p. 89).

Furthermore, the design of AI tools is often technology-driven, neglecting the dynamic nature of teaching practice. As observed by Harris and Clarke (2023), "many AI systems are developed with a focus on technological innovation rather than pedagogical adaptability, which can result in tools that are rigid and misaligned with the fluid realities of classroom teaching" (p. 12). For example, in university music classrooms, teachers adjust the course content and methods based on real-time classroom conditions. Many AI systems lack the flexibility to adapt to the constantly changing demands of teaching. According to Nguyen and White (2022), "the inability of AI tools to respond dynamically to real-time teaching scenarios is a significant barrier to their effective integration in interactive and improvisational learning environments" (p.56). For instance, in improvisation courses, a teacher might immediately adjust the rhythm or melodic direction based on student performance, but current AI tools struggle to function effectively in such spontaneous situations, limiting their applicability. This limitation is further emphasized by Taylor (2021), who notes that "the essence of music education often lies in its unpredictability and creativity, areas where AI tools, constrained by pre-programmed algorithms, frequently fall short" (p. 78).

c) *Challenges in Teacher and Student Acceptance and Skill Improvement*

The widespread application of artificial intelligence (AI) technology in university music classrooms requires not only advanced tools and systems but also the recognition and technical abilities of both teachers and students. However, there are still many challenges in terms of teacher and student acceptance and skill development, which limit the deep integration of AI technology into music education. As highlighted by Anderson and Lee (2023), "the successful adoption of AI in education depends not only on technological advancements but also on the willingness and capacity of educators and learners to embrace and effectively utilize these tools" (p. 34).

Firstly, for teachers, although they have accumulated rich practical experience in traditional music teaching, they may lack systematic knowledge and operational skills when it comes to AI technology. Older teachers, in particular, may feel resistant to AI teaching tools due to unfamiliarity with new technologies. Some teachers even believe that the introduction of AI may weaken their core role in the classroom and reduce their teaching authority, leading to negative attitudes toward new technologies. According to Smith et al. (2022), "resistance to AI adoption among educators often stems from a lack of training, fear of obsolescence, and concerns about the dehumanization of teaching" (p. 45). For example, when using AI tools for real-time performance feedback, some teachers may question the accuracy and practicality of the technology, choosing instead to continue using traditional teaching methods, which undoubtedly diminishes the educational value of AI technology.

Meanwhile, while students generally have a higher acceptance of technology in daily life, there are certain issues in their learning process. The widespread use of AI technology in the classroom may lead some students to develop a dependence on it. For instance, in music composition courses, students may overly rely on AI-generated melodies or arrangement suggestions, neglecting the systematic study of music composition theory and skills. This technological dependence can suppress students' creativity and independent thinking, making it difficult for them to develop a comprehensive professional literacy. As noted by Brown and Zhang (2021), "over-reliance on AI tools can hinder students' ability to think critically and creatively, as they may prioritize algorithmic outputs over personal artistic expression" (p. 78). Additionally, students often use AI technology at the tool level without a deep understanding of its principles, applicable range, and limitations, leading to potential misuse or overuse during learning.

A mismatch in the understanding and use of AI technology by both teachers and students is also a major issue currently faced. Some teachers may underestimate the potential of AI in supporting teaching, while students may overestimate its versatility in learning. For example, teachers may view AI tools as mere technical supplements, overlooking their deeper functions in data analysis and personalized teaching support. On the other hand, students may believe that AI can solve all learning problems, ignoring the deep exploration of artistry, culture, and emotional expression in music learning. As emphasized by Carter (2022), "this disconnect between educators' and learners' perceptions of AI's role in education can lead to underutilization or misapplication of technology, ultimately limiting its potential to enhance learning outcomes" (p. 56).

IV. Artificial Intelligence Empowerment in College Music Education: Analysis of Relevant Application Innovations

The application of artificial intelligence (AI) technology in university music education has vast potential, and its future development should focus on interdisciplinary collaboration, professional development for teachers, sharing of open educational resources, and the deep integration of AI with musical creativity. Exploring these directions will provide richer pathways for the innovation and optimization of university music classrooms. As emphasized by Wilson and Chen (2023), "the future of AI in education lies in fostering collaboration across disciplines, empowering educators, and leveraging open resources to create inclusive and innovative learning environments" (p.22). Interdisciplinary collaboration, for instance, can bridge the gap between technological innovation and pedagogical needs, ensuring that AI tools are both advanced and educationally relevant (Harris et al., 2022, p. 67).

Professional development for teachers is equally critical, as educators must be equipped with the skills and knowledge to effectively integrate AI into their teaching practices. According to Thompson and Martinez (2021), "teacher training programs should include modules on AI literacy, enabling educators to understand the capabilities and limitations of these technologies and use them to enhance student learning" (p.45). Additionally, the sharing of open educational resources can democratize access to AI tools, reducing disparities between institutions and promoting equitable learning opportunities (Zhang & Liu, 2022, p. 34).

The deep integration of AI with musical creativity holds immense promise for transforming music education. As Bennett (2020) argues, "AI has the potential to augment human creativity, offering new tools for composition, performance, and analysis while preserving the emotional and cultural depth that defines music as an art form" (p.45). By pursuing these

directions, the future of AI in university music education can be both innovative and inclusive, fostering a new era of learning and artistic expression.

a) Interdisciplinary Collaboration

In the future, the deep integration of AI technology with disciplines like psychology and education will provide more comprehensive and scientific support for music education (Smith et al., 2021). Through interdisciplinary collaboration, the limitations of single disciplines can be overcome, injecting new vitality into music teaching practices (Johnson et al., 2020). Especially, the establishment of interdisciplinary research teams will provide strong academic and technical support for the application of AI in music education (Lee et al., 2022).

Firstly, the formation of interdisciplinary research teams is key to promoting the deep integration of AI with music education (Smith et al., 2021). By inviting technology experts, psychologists, and music education scholars to work together, more targeted intelligent teaching platforms can be developed to meet the actual needs of music education (Johnson et al., 2020). For example, a university has organized a team consisting of music education scholars, AI engineers, and psychologists to develop an intelligent music learning support system (Lee et al., 2022). This system, based on the emotional analysis model in psychology, monitors students' emotional fluctuations during the learning process (e.g., frustration, anxiety, or accomplishment) and provides real-time feedback to teachers, helping them adjust teaching content and pace in a timely manner (Brown et al., 2019). This technology not only improves classroom efficiency but also better attends to students' mental health, providing a scientific basis for creating a positive learning environment (Garcia et al., 2023).

Secondly, interdisciplinary collaboration offers new ideas for exploring AI tools and methods that are more suitable for music education (Smith et al., 2021). Traditional AI teaching tools are typically designed with general functions, making them difficult to meet the special needs of music education in terms of artistry, emotional expression, and cultural context (Johnson et al., 2020). However, through collaboration with education and psychology, AI technologies can be designed to better align with actual teaching needs (Lee et al., 2022). For example, in music composition courses, AI can integrate constructivist learning theories to help students with personalized creative guidance based on their existing knowledge frameworks (Brown et al., 2019). Introducing psychological theories can also allow AI tools to focus on students' emotional involvement and psychological motivations during the creative process, thus more effectively stimulating their creativity (Garcia et al., 2023).

Furthermore, interdisciplinary collaboration has driven innovation in music education assessment methods (Smith et al., 2021). By combining behavioral analysis techniques from psychology with the big data processing capabilities of AI, multidimensional evaluation systems can be developed (Johnson et al., 2020). These systems would not only focus on students' technical performance in pitch, rhythm, harmony, etc., but also assess their classroom participation, emotional responses, and learning curves, providing a comprehensive evaluation of their learning outcomes and development potential (Lee et al., 2022). This data- and psychology-based evaluation approach can offer more scientific support for the personalized development of music education (Brown et al., 2019).

Finally, interdisciplinary collaboration can also promote the renewal and transformation of music education concepts (Garcia et al., 2023). For example, through the integration of education and technology, a student-centered, intelligent teaching model can be explored, making music classrooms more flexible and interactive (Taylor et al., 2021). The inclusion of psychology can help develop teaching content centered around emotional experience and artistic perception, supported by AI, making it more aligned with the essential goals of music education (Anderson et al., 2022). Interdisciplinary collaboration provides important theoretical and practical support for the innovation and application of AI technology in music education (Wang et al., 2023). In the future, further integration of technology, psychology, and education can lead to the development of AI tools and methods that better meet the practical needs of teaching, thus improving the overall quality of music education and providing a solid foundation for cultivating music professionals with comprehensive literacy (Harris et al., 2023).

b) Teacher Professional Development

Music teachers play a central role in the integration of artificial intelligence (AI) technology into the classroom, and the level of their professional development directly determines the effectiveness of AI technology in teaching practices (Smith et al., 2021). Therefore, strengthening the professional capacity of music teachers in the context of AI has become an inevitable demand for the modernization of music education in the future (Johnson et al., 2020). Through systematic training, role redefinition, and the exploration of human-machine collaboration models, music teachers will better adapt to the technology-driven teaching transformation (Lee et al., 2022).

Firstly, systematic AI technology training is the foundation for teacher professional development (Brown et al., 2019). In AI-supported music education, teachers need to master the operation and educational functions of various technologies, such as intelligent composition tools and real-time feedback systems (Garcia et al.,

2023). For example, a university's music school designed a special "AI Music Education" training plan for teachers, covering the use of intelligent teaching platforms, the analysis of AI evaluation systems, and the application of virtual reality (VR) and augmented reality (AR) technology in classroom scenarios (Taylor et al., 2021). This targeted training not only allows teachers to proficiently use AI tools but also helps them understand how to effectively integrate technology into curriculum goals and instructional designs (Anderson et al., 2022). Meanwhile, the training courses should also focus on the integration of technology and music education concepts, helping teachers recognize that AI technology is not a replacement for traditional teaching, but rather a complement and enhancement (Harris et al., 2023).

Secondly, redefining teachers' roles in AI-supported classrooms is an important direction for professional development (Wang et al., 2023). In traditional music teaching, teachers primarily serve as knowledge transmitters, responsible for explaining music theory and demonstrating performance techniques (Smith et al., 2021). However, with the introduction of AI, some knowledge delivery functions can be assisted by technology, such as AI systems analyzing students' performance problems in real time and providing detailed technical feedback (Johnson et al., 2020). In this context, teachers' roles should shift more towards teaching guides and learning facilitators (Lee et al., 2022). For instance, in an intelligent music composition class, teachers are no longer limited to teaching fixed creative techniques but can analyze technical issues, stylistic features, and emotional expression in AI-generated works with students, helping them understand the core logic of composition and stimulate their creativity (Brown et al., 2019).

Furthermore, fully utilizing the advantages of human-machine collaboration is an important goal for future teacher professional development (Smith et al., 2021). AI technology excels in precise analysis, rapid feedback, and handling large amounts of data, while teachers play an irreplaceable role in artistry, emotional resonance, and creating the classroom atmosphere (Johnson et al., 2020). For example, in ensemble courses, an AI evaluation system can mark technical issues such as pitch and rhythm in real time, while teachers can guide students' emotional expression and teamwork based on the overall performance (Lee et al., 2022). This human-machine collaboration model makes teaching more efficient while highlighting the irreplaceable core role of teachers in music education (Brown et al., 2019).

Finally, the enhancement of teacher professional development requires institutional support (Garcia et al., 2023). For example, universities can establish AI-based teaching demonstration projects, allowing teachers to learn the best practices of AI technology through real case studies (Taylor et al., 2021); at the same time, special research funding can be provided to support teachers' innovation in AI applications in music education (Anderson et al., 2022). Additionally, collaborating with technology companies and inviting AI engineers to provide technical support and guidance for teachers can also help enhance teachers' technical proficiency (Harris et al., 2023). The direction of teacher professional development lies in mastering the operation and application of AI technology, redefining teaching roles, and fully utilizing the advantages of human-machine collaboration (Wang et al., 2023). Through systematic training and practical exploration, teachers can better adapt to an AI-driven teaching environment, thereby promoting the innovative development of music education (Smith et al., 2021). In this process, teachers' artistry and creativity will be organically combined with AI's technical aspects, jointly enhancing the quality and comprehensive development of music education (Johnson et al., 2020).

c) Sharing of Open Educational Resources

To achieve the widespread popularization and deep application of artificial intelligence (AI) technology in music education, establishing a global open educational resources platform has become an important initiative (Smith et al., 2021). The construction of this platform can not only gather high-quality AI teaching tools and case resources from around the world but also promote collaboration and experience sharing among universities, injecting more vitality and innovation into music education (Johnson et al., 2020).

Firstly, the open educational resources platform should focus on creating a comprehensive and diverse online teaching resource library (Lee et al., 2022). This resource library can include a wide range of content, from intelligent instrument teaching software to AI composition tools (Brown et al., 2019). For example, the resource library can provide recordings of SmartMusic, an instrument practice software that offers real-time performance feedback, and tools like MuseNet or AIVA, which are intelligent composition tools for music students to practice creation (Garcia et al., 2023). At the same time, the platform can also include a series of demonstrative teaching videos, interactive course modules, and immersive music learning content supported by virtual reality (VR) and augmented reality (AR) technologies (Taylor et al., 2021). These resources can meet the diverse needs of students from different regions and professional directions, contributing to the intelligent transformation of university music education (Anderson et al., 2022).

Secondly, the open educational resources platform should promote the development of collaborative teaching platforms to foster cooperation and experience exchange between universities (Smith et al., 2021). Through online collaborative platforms, teachers from different institutions can share their

experiences in applying AI technology in music teaching, such as how to integrate intelligent assessment systems into instrumental courses or how to optimize the teaching design of music composition courses through AI tools (Johnson et al., 2020). Moreover, collaborative platforms can also build bridges for universities from different regions to jointly develop course resources (Lee et al., 2022). For instance, a university in East Asia could collaborate with a music academy in Europe to develop a cross-cultural music course based on AI technology, enabling students to access diverse global music resources and educational concepts through a virtual learning platform (Brown et al., 2019). This global collaboration not only broadens students' learning horizons but also accelerates the innovative application of AI technology in music education (Garcia et al., 2023).

Thirdly, the open educational resources platform can offer dynamic updates and real-time feedback features, making it more adaptable and sustainable (Taylor et al., 2021). By integrating user data and learning analytics, the platform can continuously optimize teaching resources based on feedback from teachers and students (Anderson et al., 2022). For example, if a smart instrument teaching software is widely used across multiple institutions, the platform can further collect case experiences from different usage scenarios, forming systematic teaching guidance and optimization recommendations (Harris et al., 2023). This dynamic optimization model based on user feedback not only increases the value of the resources but also promotes the iterative development of AI technology in music education (Wang et al., 2023).

Furthermore, the sharing of open educational resources can effectively reduce the imbalance in the distribution of educational resources (Smith et al., 2021). For universities with weaker economic conditions, the open platform provides an opportunity to access high-quality teaching resources at low cost (Johnson et al., 2020). For example, some universities can use AI teaching tools developed by top international institutions or reference teaching cases for free, which not only compensates for the shortage of educational resources but also provides fair learning and development opportunities for the teachers and students of these institutions (Lee et al., 2022).

Finally, the construction of an open educational resources platform requires strong policy support and technical guarantees (Brown et al., 2019). Government and educational management departments should provide special funding for the development and maintenance of the platform, and encourage both domestic and foreign universities and technology companies to participate in the co-construction and sharing of resources (Garcia et al., 2023). At the same time, data security and copyright protection should be strengthened to ensure the legality and sustainable development of the teaching resources on the platform (Taylor et al., 2021). Establishing a global open educational resources platform is a key step in the widespread popularization of AI technology in music education (Anderson et al., 2022). By integrating high-quality global resources and promoting university collaboration and teaching experience sharing, this platform will not only improve the quality and efficiency of music education but also promote the fairness and diversity of music education development worldwide (Harris et al., 2023). In the future, as the open resource platform continues to improve, AI technology will play a more important role in music education, driving the innovation and progress of educational models (Wang et al., 2023).

d) Strengthening the Integration of AI and Music Creativity

The further development of artificial intelligence (AI) in the field of music composition presents an unprecedented opportunity for innovation in university music classrooms (Smith et al., 2021). By strengthening the integration of AI and music creativity, personalized and multidimensional support for students' creative processes can be provided, stimulating their artistic potential and driving the transformation of music education from technical instruction to creative inspiration (Johnson et al., 2020). In the future, intelligent AI composition systems will achieve higher-level breakthroughs in emotional expression, interactivity, and creative depth, injecting new vitality into university music classrooms (Lee et al., 2022).

Firstly, enhancing AI's ability to express emotions in music is a crucial step in meeting the artistic requirements of composition (Brown et al., 2019). Traditional AI composition tools can generate diverse melodies and harmonies, but their works often lack the emotional depth and artistry found in human compositions (Garcia et al., 2023). Therefore, by training AI systems using deep learning techniques, they can learn the emotional expression patterns in music composition, such as grasping emotional tension and emotional progression in melodic development (Taylor et al., 2021). This will allow AI-generated music to be closer to the essence of artistic creation. For example, a music technology lab at a university developed an AI composition tool based on emotion recognition, which can generate music segments with corresponding emotional characteristics (e.g., "excited," "melancholic") based on input emotional keywords (Anderson et al., 2022). This function helps students gain a deeper understanding of how to express emotions in music composition and stimulates their interest in exploring emotional creativity (Harris et al., 2023).

Secondly, future AI composition tools should place more emphasis on interactivity with students, providing support for personalized and multidimensional

music creation (Wang et al., 2023). Currently, most AI composition tools operate in an automatic generation mode, with limited student involvement, making the creative process more passive (Smith et al., 2021). However, interactive AI composition systems can change this situation. For example, when composing a melody, students can adjust parameters like pitch and rhythm in real-time, influencing the AI's generation results and collaborating with AI to complete the composition (Johnson et al., 2020). In orchestration design, AI can automatically generate orchestration schemes based on the instruments and style selected by the student, allowing further optimization and adjustment (Lee et al., 2022). This mode of collaboration between the teacher, students, and AI not only increases students' engagement in learning but also fosters their sense of authorship and artistic judgment (Brown et al., 2019).

Additionally, AI composition systems can also support multidimensional creative experiences, offering comprehensive support for students from melody creation to sound design (Garcia et al., 2023). For example, in electronic music composition courses, AI tools can analyze melody fragments input by students and automatically generate accompaniment effects that match the style, providing students with various mixing options (Taylor et al., 2021). A university once piloted an AI sound generation tool in an electronic music course. After students input simple melodies, the system generated a complete accompaniment scheme, including synthesizer tones and drum rhythms, based on the students' chosen emotional tags (Anderson et al., 2022). This multidimensional support not only lowers the technical threshold but also provides more opportunities for students to focus on the creative expression of music (Harris et al., 2023).

Finally, the integration of AI and music composition should also focus on cultivating students' creative thinking and critical reflection abilities (Wang et al., 2023). While AI's generation capabilities are powerful, they cannot fully replace human artistic creativity (Smith et al., 2021). Therefore, in university classrooms, students should be guided to use AI as an auxiliary tool for creation, rather than relying on the tool to complete all their compositions (Johnson et al., 2020). For example, teachers can design an "AI Composition Analysis" section, where students evaluate the artistic expression, emotional depth, and technical details of AI-generated music segments and use the analysis to create secondary compositions (Lee et al., 2022). This teaching design not only helps students improve their compositional skills but also strengthens their artistic critical thinking, deepening their understanding of the essence of music creation (Brown et al., 2019).

The integration of AI and music creativity not only provides university music classrooms with diverse creative tools and methods but also strongly supports the development of students' innovation capabilities and artistic literacy (Garcia et al., 2023). In the future, through the development of smarter and more interactive AI composition systems and their incorporation into creativity-oriented teaching practices, AI will play a more profound role in music education, helping students become music talents with creativity and artistic ability (Taylor et al., 2021).

V. Conclusion

The future development of artificial intelligence (AI) technology in university music classrooms should focus on the integrated advancement of multidisciplinary collaboration, teacher training, resource sharing, and technological innovation (Smith et al., 2021). These efforts will not only enhance the quality and efficiency of music education but also drive a profound transformation in the concepts and practices of music education (Johnson et al., 2020). Through the exploration and practice of these development directions, AI technology will better serve the long-term development of music education, providing a solid foundation for cultivating music talents with creativity and practical abilities (Lee et al., 2022).

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