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Original Research Article

AI in Early Childhood Music Education: Current Status and Application Orientations in Teacher Training

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Abstract: A survey conducted among 128 early childhood education majors revealed high levels of both AI awareness and demand for AI integration in training, with scales demonstrating robust internal consistency (Cronbach's α = 0,800–0,897). Significant differences across academic years were observed only in the frequency of AI usage and the perception of AI specifically within music education; conversely, general awareness and training needs remained relatively uniform across the cohorts. These findings suggest that while students maintain a positive attitude toward AI, their capacity to implement it within professional contexts remains inconsistent. Furthermore, while the use of AI for general learning has become prevalent, it does not yet fully reflect pedagogical competence or the ability to evaluate learning outcomes. Notably, challenges in AI utilization persist at a significant level and do not show a marked decrease as student progress through their seniority. This study highlights a distinct gap between perception and practice, emphasizing the necessity of integrating AI into teacher education through a competency-based, oriented, and systemically supported approach, rather than merely focusing on tool accessibility.

Keywords: AI Literacy, Early Childhood Education, Music Education, Technology Integration.

1. INTRODUCTION

In the context of global digital transformation, Artificial Intelligence (AI) has increasingly emerged as a pivotal element in education. Beyond its role as a supportive tool, AI is fundamentally restructuring pedagogical methodologies, personalizing learning pathways, and fostering learner autonomy (Shemshack & Spector, 2021; Liu & Yuan, 2024). Specifically, research by Zhang *et al*., (2024) indicates that in teacher education, AI is regarded as a factor with a growing profound impact on future professional competencies—ranging from instructional design and the organization of learning activities to the development of professional digital literacy. In the field of early childhood education, where teaching is inherently linked to creativity, emotional intelligence, direct interaction, and multi-sensory experiences, AI offers significant potential for designing enriched learning environments. However, given the inherent limitations of AI, it is essential to integrate these technologies with traditional pedagogical methods to ensure educational efficacy (Cha & Daud, 2025).

Research by Yu and Ding (2020) highlights that music education for young children is a vital component of "Smart Education" and "Internet+ Education," representing an inevitable trend in the modern era. Nevertheless, contemporary scholarship has primarily focused on AI in general education or higher academic levels. Empirical evidence regarding how early childhood education (ECE) students perceive, utilize, and envision AI within their specific disciplinary context—particularly in music education—remains relatively scarce (Kim & Kim, 2024). Furthermore, most existing studies are limited to investigating general attitudes, opportunities, challenges, or technology acceptance. There is a notable lack of differentiation between critical structural dimensions, such as AI awareness, AI-assisted learning behaviors, AI literacy, and the ability to contextualize AI within specific pedagogical frameworks (Karran *et al*., 2024; Lamanauskas, 2024). This research gap results in an assessment of students' professional readiness for AI that lacks depth and fails to account for the unique characteristics of their specialized training field.

From a theoretical perspective, AI literacy is increasingly recognized as a cornerstone of teacher education. It encompasses not only technical proficiency but also the capacity to evaluate AI-generated outputs,

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ensure ethical and responsible usage, understand systemic limitations, and make informed decisions tailored to specific educational contexts. For pre-service early childhood educators, these requirements are particularly critical, as the integration of AI must be inextricably linked to young children's developmental characteristics, safety standards, content appropriateness, and the practitioner's professional accountability. Within the realm of music education, AI transcends its role as a mere technical aid; it actively facilitates the design of integrated listening–movement–creation experiences, the generation of background scores, the suggestion of melodic motifs, and the development of highly interactive activities for children (Yuan, 2024).

Consequently, elucidating the current state of awareness, usage levels, demands, and challenges related to AI among early childhood education (ECE) majors—particularly within the domain of music education—holds both academic and practical significance. Theoretically, this study contributes empirical evidence to the AI literacy framework within specialized teacher training contexts, while further distinguishing between positive attitudes toward AI and the actual capacity to implement AI in professional practice. Practically, the findings provide a robust foundation for designing AI-integrated curricula focused on professional competency development, rather than merely providing isolated tool-based skills. Furthermore, identifying the gap between awareness, practice, and the implementation of AI in music education facilitates the orientation of more appropriate pedagogical interventions in ECE teacher training. On this basis, the present study aims to describe the status of AI awareness, usage levels, needs, and perceived difficulties among ECE students, while analyzing differences across academic years.

2. LITERATURE REVIEW

Music education is widely recognized as an essential domain for fostering cognitive, emotional, social, and creative development. In recent years, the emergence of Artificial Intelligence (AI) has significantly transformed educational practices, including music teaching and learning. AI is increasingly viewed not only as a technological tool but also as an intelligent educational resource capable of supporting personalized learning, creative expression, and adaptive instruction (Luckin *et al*., 2016; Holmes *et al*., 2022). Within music education, these capabilities have opened new possibilities for designing interactive and learner-centered experiences.

One of the most significant contributions of AI to music education lies in its capacity to support music creation and composition. AI-based systems can generate melodies, harmonies, rhythmic patterns, and accompaniment tracks, thereby enabling learners and teachers to experiment with musical ideas in more accessible ways (Briot *et al*., 2020). Such technologies reduce technical barriers to music production and encourage creative engagement. In addition, AI can analyze musical performances by identifying pitch accuracy, rhythmic consistency, and expressive features, providing immediate feedback that supports skill development and self-regulated learning (Marrington *et al*., 2015). These functions contribute to more efficient assessment processes and facilitate individualized instructional support.

From a pedagogical perspective, AI aligns closely with constructivist and learner-centered approaches. Rather than functioning solely as a mechanism for content delivery, AI can support active exploration, experimentation, and problem-solving in music learning environments. According to Karsenti (2019), intelligent educational technologies enhance students' opportunities to engage in autonomous learning while maintaining high levels of interaction and motivation. Similarly, Zawacki-Richter *et al*., (2019) argue that AI can foster adaptive learning pathways by responding dynamically to learners' needs, progress, and preferences. Such adaptability is particularly valuable in music education, where learners often demonstrate diverse levels of aptitude, creativity, and musical experience.

In early childhood education, the role of AI in music learning must be understood in relation to young children's developmental characteristics. Music activities at this stage are typically grounded in play, movement, imitation, emotional expression, and sensory exploration. Research suggests that digital and AI-supported musical environments can enhance children's engagement by providing interactive experiences that combine listening, movement, singing, and creative participation (Yu & Ding, 2020). Through responsive technologies, children can receive immediate auditory and visual feedback, which contributes to sustained attention and active involvement in musical activities.

Furthermore, AI offers opportunities to support differentiated instruction in early childhood music education. Young children exhibit considerable differences in developmental pace, learning preferences, and musical abilities. Intelligent systems can assist educators in selecting age-appropriate activities and adapting learning experiences to individual needs (Holmes *et al*., 2022). AI tools may also support teachers in generating educational resources such as songs, movement activities, musical stories, and classroom accompaniment materials, thereby enriching the learning environment while reducing instructional preparation time.

Despite these benefits, researchers emphasize that AI should not replace the pedagogical, emotional, and relational dimensions of teaching that are particularly important in early childhood settings (UNESCO, 2023). Effective music education requires

human interaction, emotional responsiveness, and professional judgment that remain beyond the capabilities of current AI systems. Therefore, the educational value of AI depends largely on teachers' ability to critically evaluate and pedagogically integrate these technologies. As argued by Long and Magerko (2020), AI literacy should encompass not only technical knowledge but also ethical awareness, critical understanding, and contextual decision-making. Consequently, preparing pre-service early childhood educators to use AI effectively in music education has become an important objective of contemporary teacher training programs.

3. METHODOLOGY

Data Collection Method:

This study employed a quantitative research design using a structured questionnaire to collect data on the awareness, usage levels, perceived needs, and challenges related to Artificial Intelligence (AI) among early childhood education (ECE) majors, specifically within the context of music education. A convenience sampling technique was utilized to recruit a sample of 128 students. The survey instrument was developed based on established theoretical frameworks and previous scholarship, comprising sets of variables that reflect the study's core components. These items were measured using a 5-point Likert scale. Prior to official administration, the questionnaire underwent a pilot review to ensure clarity, coherence, and appropriateness for the target population.

Data Analysis Method:

Once collected, the data were cleaned, coded, and analyzed using appropriate statistical techniques. The internal consistency of the scales was evaluated using Cronbach's alpha coefficients, with non-compliant items being excluded from further analysis. Descriptive statistics, including Mean (M) and Standard Deviation (SD), were employed to characterize the data distribution. Due to the observed heterogeneity of variances and unequal sample sizes among the groups, Welch's ANOVA was applied to compare differences across academic years. For all statistical tests, a significance level of $p < 0.05$ was established; results with $p > 0.05$ were considered statistically non-significant.

4. RESULTS RESEARCH

The results section presents the quantitative analyses categorized by research components, including scale reliability, descriptive statistics, and tests of differences across academic years. This approach allows for the simultaneous identification of overall trends in the research variables and the degree of differentiation among groups. Consequently, it elucidates the relationship between awareness, usage behaviors, and the capacity to implement AI within the framework of early childhood teacher education.

Table 1: Sample demographics by academic year

Academic Year	Frequency (n)	Percentage (%)
First year	43	33.6
Second year	70	54.7
Third year	8	6.2
Fourth year	7	5.5
Total	**128**	**100,0**

Table 2: Reliability analysis and Welch's ANOVA results

Scale	Excluded Items	No. of Items	Cronbach's α	Mean	SD	Welch's F	P
F1	I/1	4	0.800	16.78	1.93	2.212	0.125
F2	-	5	0.821	20.34	2.80	5.453	0.008
F3	-	5	0.895	20.14	3.05	3.303	0.041
F4	IV/3	3	0.838	12.52	1.87	0.206	0.891
F5	V/5	4	0.897	14.12	3.56	2.642	0.080

Perceptions of AI in Education

The AI awareness scale demonstrated robust internal consistency following the exclusion of item I/1 (Cronbach's $\alpha = 0.800$). The mean score was 16.78/20, which translates to an average of 4.20 per item, indicating that students generally maintain a positive perception of AI's role in their studies and teacher training. However, Welch's ANOVA revealed that differences across academic years were not statistically significant, $F(3, 16.5) = 2.212$, $p = 0.125$. These findings suggest that AI awareness tends to be relatively uniform across the entire sample, implying that such perceptions may constitute a foundational awareness that is largely independent of the formal training progression.

Students' Levels of AI Usage

As illustrated in Table 2, the AI usage scale demonstrated high internal consistency (Cronbach's $\alpha = 0.821$). The overall mean score reached 20.34/25, equivalent to 4.07/5, reflecting a relatively high frequency of AI integration into students' learning activities. In contrast to the awareness component, Welch's ANOVA indicated statistically significant differences in usage levels across academic years, F(3,

17.8) = 5.453, p = 0.008. Descriptively, second-year students exhibited the highest mean scores, followed by those in their third, first, and fourth years, respectively. This finding suggests that AI usage does not follow a linear progression relative to seniority; instead, it may be more heavily influenced by specific academic requirements, the intensity of digital tool integration, and the unique characteristics of each training phase.

Perceptions of AI in Music Education

As shown in Table 2, the scale measuring perceptions of AI within the specific context of music education demonstrated excellent internal consistency (Cronbach's α = 0.895). The mean score was 20.14/25, equivalent to 4.03/5, indicating that students hold a notably positive view of AI's potential within their specialized field. Welch's ANOVA results revealed statistically significant differences across academic years, F(3, 20.0) = 3.303, p = 0.041. Descriptively, fourth-year students recorded the highest scores, closely followed by second-year students, while first-year students exhibited the lowest levels. These findings suggest that when AI is contextualized within a specific professional domain, the degree of differentiation among cohorts becomes more pronounced compared to general awareness. This implies that the ability to envision and evaluate AI applications in music education is significantly contingent upon specialized academic experience.

Demand for AI Application in Teacher Training

After refining the scale by excluding item IV/3, the AI application demand scale demonstrated good internal consistency (Cronbach's α = 0.838). The overall mean score reached 12.52/15, equivalent to 4.17/5, reflecting a high demand among students for learning, guidance, and support in utilizing AI for professional training. However, the differences across academic years were not statistically significant, F(3, 18.2) = 0.206, p = 0.891. These results indicate that the demand for AI integration is relatively universal across the entire sample, regardless of the students' current stage in the training program. This implies that AI should be regarded as a foundational component that necessitates early and continuous integration throughout the early childhood teacher education curriculum.

Perceived Difficulties in Utilizing AI

The scale measuring difficulties in utilizing AI demonstrated excellent internal consistency following the exclusion of item V/5 (Cronbach's α = 0.897$). The mean score was 14.12/20, which translates to 3.53/5, indicating that students still encounter substantial obstacles when accessing and employing AI tools. Although Welch's ANOVA did not yield statistically significant differences across academic years, F(3, 18.3) = 2.642, p = 0.080, descriptive trends revealed higher levels of perceived difficulty among second- and third-year students. This result suggests that obstacles to AI utilization do not naturally diminish over the course of academic seniority. Instead, overcoming these challenges likely requires intentional support from the training curriculum, particularly regarding tool operation, output evaluation, and the contextualization of AI within specific pedagogical frameworks.

5. DISCUSSION

The findings indicate that early childhood education (ECE) majors maintain a positive perception of Artificial Intelligence (AI) alongside a distinct demand for AI-related training. However, significant variations across academic years were observed only in usage levels and the ability to envision AI within the context of music education, whereas general awareness and training needs remained relatively uniform. This suggests that while a favorable attitude toward AI has become pervasive, the actual capacity to employ and contextualize AI within a specialized field depends more heavily on specific learning experiences. From a professional standpoint, students' nascent conceptualization of AI for tasks such as music material design, background score generation, or organizing learning experiences for children demonstrates the potential for AI integration in teacher education. Nevertheless, a gap persists between awareness and practical implementation, reflecting that mere access to tools does not equate to the formation of professional competence.

The lack of variation in demand across academic years implies that AI should be treated as a foundational component of the curriculum, necessitating a continuous integration roadmap rather than being confined to specialized modules. Furthermore, the fact that difficulties in AI utilization do not diminish significantly over time suggests that these competencies do not develop spontaneously. Instead, they require intentional support through structured learning activities, guidance, and specific feedback. These results also imply that the focus of training should transcend tool proficiency; it must aim toward the capacity to select, evaluate, and adapt AI-generated outputs for specific educational contexts, particularly those involving young children.

This study is not without limitations. The current data primarily allow for descriptive analysis and inter-group comparisons, which may not fully capture the intricate structures and underlying relationships between research variables. Future research should expand the analysis with more comprehensive datasets and advanced statistical methods to enhance the robustness of the findings.

6. CONCLUSION

In conclusion, ECE students exhibit a positive disposition toward AI and a clear demand for equipping themselves with AI competencies for their future careers. However, AI usage levels and the capacity to envision its application in music education are inconsistent across

academic cohorts, while significant obstacles to AI utilization remain.

Theoretically, this study suggests a necessary distinction between AI awareness, general AI-assisted learning behaviors, and the ability to contextualize AI within specialized pedagogical frameworks. While interrelated, these three dimensions are not identical. Therefore, assessing pre-service teachers' readiness for AI should go beyond general attitudes or technological enthusiasm. Practically, the results suggest that integrating AI into ECE teacher training should be implemented as an oriented process of digital professional development, supported by a clear roadmap and assistance mechanisms. Relying solely on tool accessibility will likely result in a transient impact. Conversely, if AI is positioned in relation to instructional design, material evaluation, professional ethics, and pedagogical decision-making, it can become a transformative resource for innovation in teacher education.

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