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Original Research

Artificial Intelligence in Teacher Education: Exploring Pre-Service Teachers' Perspectives Through Creative Music Projects for Professional Learning

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Abstract: This study explores the integration of generative artificial intelligence (AI) into the initial training of pre-service teachers through creative music projects. As AI becomes increasingly embedded in educational practice, teacher education must address its pedagogical potential and limitations. Grounded in qualitative, interpretive, and exploratory methods, the research examines how pre-service teachers engage with AI-supported music creation by comparing experiences with and without the use of generative AI tools, using individual reflections and group e-portfolios for triangulation. Thematic analysis of individual reflections and group e-portfolios identified key opportunities and challenges associated with AI integration. Findings suggest that generative AI can broaden access to creative engagement by enhancing inclusivity, encouraging experimentation, and expanding musical expression. However, tensions also emerged concerning authorship, learner autonomy, and dependence on algorithmic output. The comparative structure of the learning experience enabled participants to reflect critically on the pedagogical implications of AI use. While non-AI processes demanded greater technical skill, they were associated with deeper collaboration, creative decision-making, and artistic ownership. This study contributes to current discussions on digital pedagogy and teacher education by highlighting the need for ethically informed, critically guided AI practice in creative disciplines. It emphasizes the importance of interdisciplinary, reflective practice in developing teacher agency, digital competence, and inclusive pedagogical approaches within higher education.

Keywords: *Artificial Intelligence, Creativity, Music Education, Professional Learning, Teacher Education*

Introduction

Artificial intelligence (AI) in education is receiving significant attention and influencing various disciplines, educational levels, and pedagogical approaches (Crompton and Burke 2023; Holmes et al. 2022). Much of the discourse has focused on administrative efficiency, assessment, and adaptive learning technologies. However, the pedagogical potential of AI in creative fields remains underexplored in teacher education. Therefore, it is essential to prepare future educators to develop professionally in complex digital environments as they influence student learning, self-expression, collaboration, and critical engagement with technology.

This study addresses this gap by examining how pre-service teachers engage with generative AI through interdisciplinary artistic creation. Specifically, it explores the role of AI tools in supporting creative music composition within teacher training programs. Influential models

have framed technology integration in education, such as the Technological Pedagogical and Content Knowledge (TPACK) model (Mishra and Koehler 2006), which highlights the interplay between teachers' content, pedagogical, and technological knowledge, and the SAMR (Substitution, Augmentation, Modification, and Redefinition) model (Caukin and Trail 2019; Puentedura 2016), which categorizes four levels of technology use, from simple substitution of traditional tools to the redefinition of learning tasks.

We adopted the DigCompEdu framework (Redecker and Punie 2017) here because it offers a competence-based approach that extends beyond technical proficiency to encompass pedagogical intentionality, creative engagement, and ethical reflection (European Commission 2022). Within this framework, Areas 1 (Professional Engagement) and 3 (Teaching and Learning) are especially relevant, as they emphasize collaboration, reflection, and the design of meaningful learning activities. These areas resonate with this study, where pre-service teachers engaged with generative AI not only as a technical tool but also as a catalyst for creative, interdisciplinary, and ethically responsible practice. These dimensions are relevant for preparing teachers to address the opportunities and challenges posed by generative AI in education.

The research draws on a project-based learning experience in which participants created music using both AI-supported and traditional, non-AI approaches. This comparative design enabled participants to critically evaluate the opportunities, limitations, and educational implications of each method. Through reflective narratives and collaborative e-portfolios, the study investigates how these dual experiences influenced their understanding of creativity, autonomy, collaboration, and professional practice. In doing so, it contributes to the growing body of literature advocating for ethically grounded and pedagogically meaningful integration of AI in higher education, particularly in the arts and teacher education contexts.

Theoretical Framework

AI in Education and Teacher Training

The integration of AI into education has moved beyond speculation to become a transformative force reshaping teaching, learning, and institutional policy. In teacher education, AI introduces both opportunities and challenges, requiring critical reflection on digital competence, pedagogical practices, institutional adaptation, and ethical considerations. Recent international reports and research provide a foundation for embedding AI meaningfully into the professional development of future educators.

According to the *Ethical Guidelines on the Use of AI and Data in Teaching and Learning for Educators* (Holmes et al. 2022), AI literacy is becoming essential for educators at all levels. These guidelines emphasize that teachers must develop not only technical proficiency but also a critical awareness of the ethical dimensions of AI use. Educators are encouraged to consider issues such as transparency, bias, data privacy, and fairness, aligning technology use with democratic and human-centered values.

The *Guidance for Generative AI in Education and Research* (UNESCO 2023) reinforces these principles by proposing a comprehensive global policy framework centered on human agency, inclusion, and responsible innovation. Among its ten key recommendations for educational systems are the promotion of AI literacy, the preservation of teacher-led pedagogy, and the strengthening of institutional policies to ensure equity and accountability. Teacher education is identified as a strategic priority in preparing educators to evaluate, design, and implement AI in ways that are both innovative and ethically grounded.

These perspectives are reinforced by institutional-level reflections presented by Cadima et al. (2024), who argue that Portuguese universities must assume responsibility for preparing future professionals to use AI-enhanced environments. They stress that the growing integration of AI needs a re-examination of higher education structures, including infrastructure, digital resources, curricular frameworks, pedagogical materials, and teaching methodologies.

Although this transition presents significant challenges, it also underscores the need for ethical, responsible, and strategically supported AI integration. Such approaches extend beyond classroom practice to include institutional governance, data security, and the broader responsiveness of universities to emerging societal needs. Cadima et al. (2024) further highlight the importance of investing in research capacity and institutional expertise to prepare both students and educators for these evolving demands.

Research on AI in higher education supports these institutional and policy-oriented insights. Zawacki-Richter et al. (2019) observe that discussions often emphasize the technical capabilities of AI while underrepresenting the pedagogical role of educators. They call for a more nuanced exploration of how AI can be meaningfully and critically incorporated into teaching, particularly in teacher education, where educators must act not only as users of digital tools but also as facilitators of reflective and ethically grounded engagement.

St-Hilaire et al. (2022) demonstrate that AI-powered systems, such as intelligent tutoring systems (ITS), can personalize learning pathways and support student progression. However, they emphasize that such technologies must be guided by pedagogical intent, especially in domains like music education, where interpretation, emotion, and creativity are integral to learning.

Similarly, Zeivots and Shalavin (2024) highlight codesigning learning experiences that promote meaningful student engagement with digital tools. Although their research focuses on business education, their emphasis on teacher agency and participatory design has broader relevance, including in creative and arts-based disciplines such as music.

Collectively, these perspectives call for a redefinition of teacher education in the age of AI, not as a process of technical upskilling alone but also as a comprehensive pedagogical and institutional transformation. Pre-service teachers must nurture AI literacy that is functional, ethical, creative, and critically reflective, capacities closely connected to broader notions of teacher critical reflection and agency. Teacher critical reflection (TCR), rooted in the work of Dewey (1938) and Schön (1983), and further developed by Brookfield (2017), enables

educators to examine their practice purposefully to resolve issues, challenge assumptions, and align their actions with professional and ethical values (Sullivan et al. 2016).

Agency is built not solely upon the transmission of specific knowledge. It involves a global process of learning, allowing students to take the initiative, apply their knowledge in new situations, and reflect on their actions while taking responsibility for them (OECD 2025). It is fostered through relationships and strengthened when learners engage in tasks that encourage self-directed experimentation and exploration of alternative possibilities, challenging existing understandings (Schoon 2018).

In this context and within the collaborative music projects proposed to pre-service teachers, creative agency becomes tangible when students compose, author, and shape their own ideas by actively engaging with music, developing critical thinking, and expressing unique perspectives (Bo 2022). These experiences with generative AI position music not only as a tool for artistic creation but also as a lens for examining broader questions of teacher training, including pedagogical, professional, and ethical dimensions related to authorship, creative agency, and the human experience of learning.

The study contributes to this evolving discourse by exploring how pre-service teachers engage with generative AI through collaborative music projects. These projects serve not only as artistic outputs but also as reflective learning experiences, offering insights into the pedagogical, professional, and ethical dimensions of AI integration in education.

Generative AI in Music Education

The rise of generative AI in education has renewed interest in its potential to foster creativity, particularly in domains such as music, where AI tools can generate melodies, harmonies, and even entire compositions. Recent studies have examined AI not only as a compositional aid but also as a pedagogical tool capable of fostering creativity, inclusion, and digital literacy (Li and Wang 2024).

Evidence suggests that generative AI can lower the barriers to music creation by enabling learners with limited technical or theoretical backgrounds to engage in composition, thereby enhancing accessibility and participation (Merchán Sánchez-Jara et al. 2024). When used with pedagogical intent, these tools can encourage divergent thinking, artistic risk-taking, and iterative exploration, principles closely aligned with constructivist and arts-based approaches to teaching and learning.

For teacher education, these possibilities are especially significant: engaging pre-service teachers in AI-supported music projects not only deepens their creative and digital competencies but also prepares them to design inclusive, interdisciplinary learning experiences in future classrooms. Nevertheless, concerns persist regarding the potential for superficial engagement, diminished authorship, and reduced student agency, particularly when learners become overly reliant on AI-generated outputs (Cheng 2025).

Beyond expanding creative possibilities, AI tools also provide opportunities for interdisciplinary learning. AI-enabled music composition can serve as a bridge between musical, literary, and visual practices, supporting holistic engagement and multimodal expression. Recent studies (e.g., Dann et al. 2024) further emphasize how AI can personalize learning and assessment in creative disciplines by adapting feedback and content to individual learner needs. However, the effective and responsible application of AI in music education requires the support of frameworks that encourage ethical integration and critical reflection.

In response to this need, models such as the Artificial Intelligence Assessment Scale (AIAS) proposed by Perkins et al. (2024) offer structured guidance for balancing innovation with ethical responsibility. These frameworks identify the importance of transparency, inclusivity, and pedagogical intention. These principles are relevant to teacher training programs and the preparation of future educators.

The literature calls for designing intentional and reflective learning experiences in teacher education, where AI tools function as both creative resources and instruments for critical inquiry. In pre-service teacher training, the integration of generative AI into music education presents a timely opportunity to connect artistic exploration with digital pedagogy.

This study contributes to this growing field by examining how pre-service teachers engage with generative AI in collaborative music-making, while reflecting on its implications for creativity, pedagogy, and professional learning development. As generative AI continues to evolve, its role in music education will be shaped not only by its technical capabilities but also by the pedagogical quality and ethical vision that inform its use.

Digital Pedagogy and Creative Engagement

This study is situated within the broader context of digital competence development and pedagogical innovation, aligning with the *European Framework for the Digital Competence of Educators* (Redecker and Punie 2017). This framework offers a comprehensive model to guide educators in the meaningful integration of digital technologies into their instructional practices. It highlights professional engagement, teaching and learning, the use of digital resources, and learner empowerment. These areas are highly relevant to the pedagogical application of generative AI in teacher education.

The areas of professional engagement and teaching and learning emphasize experimentation with emerging technologies, collaborative pedagogical development, and the promotion of learner creativity and autonomy. These principles informed the design of the learning experience, in which pre-service teachers engaged in collaborative, interdisciplinary projects involving the co-creation of music using AI tools. This hands-on, reflective approach encouraged critical digital engagement and framed AI not as a prescriptive instrument but as a pedagogical partner.

The study also responds to international guidance from UNESCO (2023) and the European Commission (2022), both of which stress the importance of integrating AI in ways

that are ethically responsible, human-centered, and conducive to inclusive and creative learning. These frameworks emphasize the development of human capacity to ensure that emerging technologies serve educational goals rooted in equity and meaningful engagement. They advocate for preparing educators to explore, question, and repurpose digital tools within diverse pedagogical contexts.

This approach is particularly relevant in teacher training systems such as the Portuguese generalist model, where future educators teach across disciplines, including music and the arts. As Milhano (2021) has noted, a gap remains in the preparation of both in-service and pre-service teachers regarding the pedagogical use of technology in creative fields. In the absence of targeted learning experiences that link digital tools with artistic expression, teachers may struggle to realize the potential of AI to support inclusive, engaging, and innovative educational practices.

By embedding generative AI into creative, interdisciplinary music-making tasks, this study proposes a conceptual model for fostering AI literacy and digital pedagogical competence in teacher education (Figure 1). The model highlights four interrelated dimensions: AI integration, creative pedagogy, digital competence, and teacher professional development, and shows how they interact through shared constructs such as authorship, agency, reflection, collaboration, pedagogical intent, ethical use, and innovation. It frames pre-service teachers as reflective practitioners who learn to integrate technology with awareness, creativity, and purposeful pedagogical intent, preparing them to negotiate technological change in education.

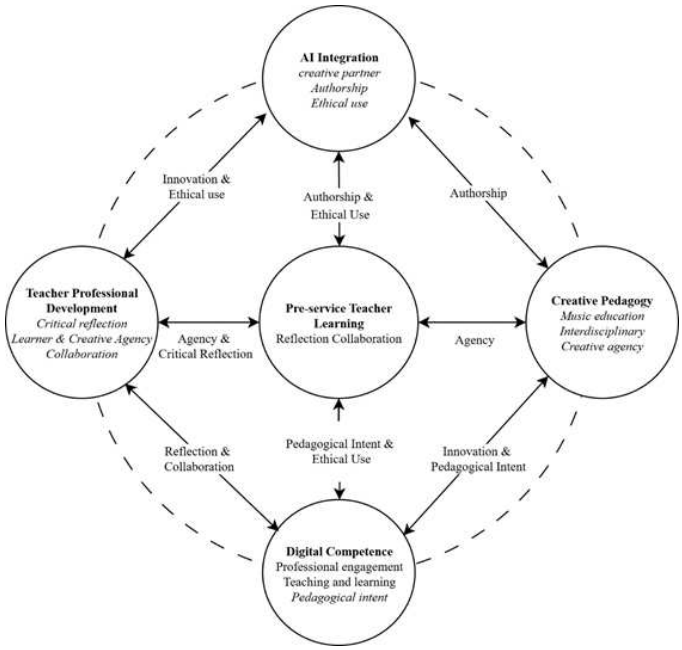

Figure 1: Conceptual Model of Pre-Service Teacher Professional Learning with Generative AI Through Creative Music Projects

The following section outlines the methodological design used to examine how pre-service teachers engaged with AI-supported music projects and how they perceived the contribution of these experiences to their professional learning.

Methods

Research Design

This study employs a qualitative, interpretive, and exploratory design, suitable for investigating complex educational phenomena within real-world settings (Edmonds and Kennedy 2017). It seeks to understand how pre-service teachers experience and reflect on the use of generative AI in creative music-making during their initial teacher education. Given the emergent and context-specific nature of AI in educational contexts, particularly within artistic and interdisciplinary practices, a qualitative approach enables an in-depth exploration of participants' perspectives, experiences, and meaning-making processes (Lune and Berg 2017).

An interpretive paradigm was selected to emphasize the situated knowledge and subjective understandings of participants, offering insights into teaching and learning processes from their vantage points (Krmac 2022). This approach is consistent with the complex ways in which future educators engage with AI tools, not merely as technological mechanisms but also as mediators of artistic, pedagogical, and collaborative experiences. The study is further characterized as exploratory, given that it addresses a relatively under-researched intersection: the integration of generative AI into music education within teacher preparation programs.

Grounded in a socio-constructivist epistemology, the study views participants as active agents in constructing meaning through collective artistic expression and reflective practice. Data was collected through individual written reflections and collaborative digital portfolios (e-portfolios), developed during and after participation in an interdisciplinary creative project. These materials were chosen to capture both individual and group-level learning, creative decision-making, and critical engagement with technology.

This methodological design supports the study's aim to identify emergent themes, document perceived affordances and limitations of AI-assisted creative work, and offer pedagogical insights into the integration of digital tools in teacher education. The following sections describe the research context, participant profile, and procedures used for data collection and analysis.

Participants and Setting

The study was conducted within the framework of an initial teacher education program at a public higher education institution in Portugal. The participants included fifty-four pre-service teachers enrolled across three cohorts of professional master's degree programs in Preschool Education and Primary Education Teaching. These generalist educators-in-training

participated in a curricular unit focused on artistic education, in which music creation was explored through interdisciplinary and technology-enhanced practices.

The learning experience followed a project-based, collaborative model (Milhano 2024), wherein participants worked in small groups to develop an original artistic creation inspired by the literary work *O Senhor Valéry* by Portuguese author Gonçalo M. Tavares. The project required participants to create original music compositions using two distinct approaches: one with generative AI tools and another relying solely on non-AI methods. This comparative structure was a central feature of the pedagogical design, intended to foster critical reflection on the affordances and limitations of AI in creative processes.

Participants engaged with a range of digital and AI-based music tools and were encouraged to experiment and critically reflect on their functionality and pedagogical potential. The creative process included hands-on experimentation with generative music platforms, such as Lowdly, AI Music Factory, Muzaic Home, Udio, and aimusic.so, as well as more traditional digital audio workstations. The educational design supported collaborative planning, creative problem-solving, and reflective practice, competencies aligned with the DigCompEdu framework, particularly in the areas of Teaching and Learning, Digital Resources, and Learner Empowerment (Redecker and Punie 2017).

All participants had prior formative experiences in music, having completed undergraduate coursework in Basic Education. However, the depth and nature of these experiences varied depending on their institutional backgrounds. Additionally, the participants brought diverse sociocultural perspectives, levels of technological fluency, and a range of formal and informal musical experiences. This diversity contributed to a rich dataset, offering nuanced insights into how pre-service teachers engage with AI-supported artistic practices within teacher education settings.

Data Collection

Data collection captured both individual and collective experiences of pre-service teachers as they engaged in interdisciplinary artistic creation involving generative AI. The data sources were purposefully selected to reflect participants' creative processes, collaborative dynamics, and critical reflections throughout the project-based learning experience. Two primary forms of qualitative data were collected: individual written reflections and group e-portfolios.

Individual Written Reflections

Following the project, each participant was asked to submit a personal written reflection. These texts responded to specific prompts concerning their learning experience, including their engagement with AI tools, perceptions of the creative process, challenges encountered, and the perceived relevance of the activity for their future teaching practice. The reflections offered insights into participants' interpretations of the artistic and technological experience,

contributing to a more nuanced understanding of how AI was received and integrated into their creative and pedagogical thinking.

Group e-Portfolios

Each group (comprising three to five members) developed a digital e-portfolio documenting their artistic project. These e-portfolios included initial project plans, sketches and visual elements, musical compositions (including AI-generated pieces), annotated audio files, performance notes, and audiovisual documentation of the final artistic presentations. Groups also submitted a narrative reflection describing their collaborative process, aesthetic choices, and the use of AI tools in music creation. These multimodal documents served as evidence of artistic development, interdisciplinary dialogue, and collaborative negotiation.

The digital tools used to create the e-portfolios are widely adopted in arts education and teacher training. As noted by Barrett (2007) and Totter and Wyss (2019), e-portfolios function as digital collections of materials that document learning processes, including demonstrations, resources, and creative outputs (Lorenzo and Ittelson 2005). In addition to supporting reflection and assessment, e-portfolios generate rich multimodal data in the form of written narratives, images, audio recordings, videos, and other visual documents (Meyer et al. 2010).

All materials were collected in digital format via the institution's learning management system. This structure provided consistent access to project outputs and reflections, while also supporting the organization and preparation of data for analysis. Ethical procedures included obtaining informed consent, anonymizing participants' data, and securing the storage of digital files.

Data Analysis

A thematic analysis approach was employed to examine the data, facilitating the identification and interpretation of recurring patterns within both individual reflections and group e-portfolios (Braun and Clarke 2006). This method reinforced a systematic reading of the data (Plano Clark and Creswell 2015), enabling the exploration of how pre-service teachers experienced and made sense of AI-supported, interdisciplinary artistic creation.

To further capture participants' lived experiences, the analysis incorporated principles of phenomenological reduction, particularly in the examination of personal narratives (Edmonds and Kennedy 2017). The reflective texts provided insight into participants' internal meaning-making processes, contributing to a composite understanding of their engagement with creative pedagogy and emerging technologies.

Coding was conducted inductively with recurring patterns clustered into broader themes that were refined through iterative comparison and triangulation across data sources. The themes were aligned with the study's objectives and guided the subsequent organization of findings. Particular attention was paid to contrasting experiences between music creation

processes using AI tools and those without, with a focus on collaboration, creative autonomy, and pedagogical reflection. Consistent with the approach described by Merriam and Tisdell (2016), the goal was to generate insights grounded in participants' perspectives rather than to validate pre-existing assumptions. Thematic interpretation was guided by the study's aims and situated within broader discussions on generative AI in music teacher education (Cheng 2025) and the European DigCompEdu framework (Redecker and Punie 2017).

The final themes are presented in the next section, structured around the study's three guiding research focuses: (1) the challenges encountered during group music creation, comparing work with and without generative AI; (2) the contributions and opportunities these creative processes offered for professional development; and (3) the perceived influence of AI on pedagogical practices in music education, particularly concerning creativity and autonomy.

Findings

The findings are organized into three interrelated themes that emerged from participants' reflections and creative outputs: (1) challenges in music creation: collaborative processes with and without AI; (2) contributions to professional learning; and (3) pedagogical implications of generative AI.

The project-based learning structure enabled participants to engage directly with both AI-supported and traditional music creation methods, fostering critical reflection on collaboration, creativity, and professional development. This dual-mode experience provided a robust foundation for thematic analysis, offering a deeper understanding of how emerging technologies intersect with artistic practice and teacher professional learning.

Challenges in Music Creation: Collaborative Processes with and Without AI

Participants identified challenges across both creative conditions. Table 1 presents a comparative overview of the challenges, which included issues related to creative alignment, communication, technical execution, collaborative workflow, feedback practices, and ethical considerations.

In AI-assisted experiences, the most frequently reported difficulty was aligning AI-generated outputs with the group's artistic intent. Although participants acknowledged that AI tools could produce musically coherent material quickly, they often found the outputs lacking in emotional depth and narrative cohesion. Many also expressed frustration with the difficulty of "communicating" effectively with the AI, specifically, in formulating prompts that yielded satisfying musical results. These limitations often led to a perceived disconnect between the group's vision and the final product.

By contrast, non-AI experiences required more technical skill and creative input from all group members. While this extended the time for the music production, it fostered a stronger sense of artistic ownership and collaborative engagement. Participants reported that the

human-only process promoted more intuitive decision-making and deeper interpersonal negotiation, even as it demanded more extensive coordination and problem-solving.

Across both conditions, participants emphasized the importance of clear role definition, effective communication, and structured pedagogical support when incorporating AI into creative learning environments.

Table 1: Summary of Challenges Identified in Music Creation with and Without Generative AI

Challenge Area	*AI-Assisted Music Creation*	*Non-AI Music Creation*
Creative Vision Alignment	Difficulty aligning AI-generated outputs (e.g., rhythms and melodies) with the group's artistic goals.	Shared interpretation aided alignment, although options were more limited.
Human–AI Communication Barriers	Misunderstandings in prompting and interpreting AI responses led to frustration or misdirection.	Human communication errors occur but are often more transparent and negotiable.
Balancing AI Support vs. Individual Contribution	Risk of overreliance; some students felt less ownership of the final music.	A greater sense of individual contribution and creative agency.
Technical Challenges with Musical Elements	Difficulty defining nuanced musical elements like rhythm, tempo, tuning, and dynamics using prompts alone.	Required stronger musical skills but allowed more direct control.
Collaborative Workflow and Communication	Additional complexity in coordinating human and AI roles; unclear role definitions at times.	Roles are defined more naturally; they still require collaboration and communication.
Feedback and Evaluation	Difficulty offering feedback on AI-generated elements; blurred authorship hindered peer review.	Feedback is more dialogical and process-focused; grounded in peers' visible contributions.
Feedback and Evaluation	Concerns about creativity erosion, authenticity, and diluted learning outcomes.	Stronger sense of authorship, although potentially less exploration of alternative musical resources.

These findings underscore the need for structured pedagogical scaffolding when integrating AI into creative educational settings. As participants observed, generative AI can facilitate rapid ideation and expand access to music-making for learners with varying levels of musical experience. However, its effective use requires intentional instructional design, critical reflection, and collaborative strategies to prevent disengagement or overly superficial engagement with the creative process.

The dual-mode experience, creating music with and without AI, proved particularly effective in encouraging participants to reflect on the opportunities and constraints of both

approaches. By navigating the interplay between human and machine creativity, pre-service teachers developed a nuanced understanding of the pedagogical implications of AI in the arts. This reflective engagement, grounded in creative and ethical considerations, positioned them to make more informed decisions about technology in their future teaching practice.

Contributions to Professional Learning

The project-based, interdisciplinary learning experience contributed to participants' professional development as future educators. Thematic analysis of individual reflections and group e-portfolios revealed five main areas of influence: (1) development of key skills; (2) enhancement of collaboration and inference making; (3) promotion of divergent thinking and cultural awareness; (4) improvement of pedagogical strategies; and (5) reflective practice for continuous learning. These dimensions express current literature on teacher education and digital pedagogy.

Development of Key Skills

Participants reported growth across several competencies. Generative AI encouraged risk-taking and experimentation, building digital literacy, and confidence with emerging tools. Non-AI composition required closer attention to musical form and collaboration, reinforcing creative authorship and expression. These experiences enabled students to link theory and practice, strengthening both technical skill and professional agency in ways directly relevant to their future teaching.

Many participants described moving from initial uncertainty to growing confidence with digital platforms, a progression consistent with DigCompEdu's dimensions of empowerment and innovation (Redecker and Punie 2017). As one noted, "It was challenging, but over time we gained confidence in exploring and adapting the tools to our ideas." Others highlighted gains in critical thinking through artistic and technological practices: "[this process] developed my critical thinking because I was able to improve my skills while working with different forms of art and technology." Together, these experiences fostered professional learning grounded in creative agency, technological fluency, and pedagogical adaptability.

Enhancing Collaboration and Inference Making

Group-based artistic work fostered meaningful collaboration, as participants negotiated decisions, synthesized perspectives, and interpreted literary and musical content together. They emphasized listening, consensus-building, and adapting ideas in response to peers, which strengthened inferential reasoning when translating concepts across sound, imagery, and movement. One participant reflected, "By listening to others, we managed to connect ideas and create something none of us would have made alone."

These dynamics echo Cheng's (2025) claim that AI-supported music-making can enhance collective meaning-making. The interdisciplinary design thus offered a platform for collaboration, reflexivity, and shared authorship, competencies central to contemporary teacher education.

Promoting Divergent Thinking and Cultural Awareness

The interdisciplinary design of the project stimulated divergent thinking by encouraging participants to explore varied artistic possibilities. Pre-service teachers experimented with different genres and instrumental combinations, often drawing on the narrative and cultural dimensions of the selected literary texts. Integrating AI tools alongside traditional compositional methods expanded their stylistic range and encouraged engagement with unfamiliar creative territories.

Several participants reflected on how the project pushed them beyond their artistic comfort zones. One student noted, "I never imagined using electronic sounds with a classic story, but it pushed us to think outside the box and resulted in an unexpected combination." This echoes Merchán Sánchez-Jara et al. (2024), who highlight AI's potential to expand creative horizons and democratize access to diverse artistic modes. Another student wrote, "I was able to create works that inspired me in meaningful ways…the integration of creativity, technology, and collaboration changed the way I view education." Through the interplay between human interpretation and AI-generated suggestions, participants developed culturally rich, multi-voiced narratives that underscored the value of pluralistic and inclusive approaches to creativity in teacher education.

Improving Pedagogical Strategies

Participants showed a strong capacity to reflect on how their interdisciplinary, AI-enhanced creative experiences could inform future teaching. Many highlighted the potential of generative AI tools as pedagogical scaffolds that promote inclusion by enabling broader participation, regardless of musical or technological proficiency. Rather than replacing human creativity, AI was perceived as a complementary asset. When used intentionally, AI enriches exploratory, student-centered pedagogies.

This stance relates to Area 3 of the DigCompEdu framework (Teaching and Learning), which emphasizes using technology to address diverse learning needs and foster student autonomy (Redecker and Punie 2017). As one participant shared, "The integration of different artistic languages and the use of technological tools expanded my understanding of how to create engaging learning experiences."

Students also valued the cross-curricular nature of project-based tasks, noting how they linked music, language, drama, and digital literacies. This resonates with Milhano (2021), who stresses the role of artistic expression and technological fluency in teacher training.

Reflections further support Merchán Sánchez-Jara et al. (2024), who argue that, when ethically guided, AI-assisted music education can foster inclusive and imaginative learning.

Several participants also raised ethical concerns, echoing Perkins et al. (2024) on the need to safeguard authorship, agency, and reflection. They envisioned AI not as a substitute for teacher creativity but as a catalyst for dialogical, multimodal, and inclusive educational experiences, an approach consistent with UNESCO's (2023) call for ethically responsible, human-centered AI in education.

Reflective Practice for Continuous Learning

The reflective structure of the project, supported by individual narratives and collaborative e-portfolio documentation, encouraged participants to examine their learning. Students described moments of uncertainty, experimentation, and re-evaluation, highlighting trial and error as central to both artistic creation and technological exploration. This stance fostered adaptability and lifelong learning, resonating with the interpretive focus of the study and the emphasis on reflective agency in teacher education (Edmonds and Kennedy 2017).

Aligned with the DigCompEdu framework (Redecker and Punie 2017), participants stressed how reflection deepened learning across artistic fields, reframing challenges as opportunities. As one participant explained, "Throughout the entire process, I always felt a sense of purpose in the activities I completed, which kept me motivated along the way." This statement underscores the contributions of reflection in fostering engagement and creating meaning.

This echoes Milhano's (2021) analysis of Portuguese teacher education, which argues that reflective practice integrating artistic expression and digital tools is vital for preparing educators to meet evolving pedagogical demands. In this study, reflection functioned not merely as self-assessment but as a transformative process shaping professional identities, ethical perspectives on technology, and commitment to designing inclusive and creative learning environments.

Pedagogical Implications of Generative AI

Pre-service reflections revealed a growing awareness of both the pedagogical possibilities and the constraints of generative AI in educational settings. Rather than seeing AI as a novelty or purely technical tool, they recognize it as a resource with the potential to enrich classroom practice. They highlighted how AI could support inclusive, creative, and personalized learning, while raising critical questions about authorship, student autonomy, and the broader aims of education.

These insights align with the study's interpretive and phenomenological orientation (Edmonds and Kennedy 2017), which focused on how participants made meaning through AI-supported, interdisciplinary artistic experiences. The themes that arise from the narratives and collaborative e-portfolios are closely related to DigCompEdu. This alignment is

particularly evident in three key areas: empowering learners, engaging professionals, and using digital tools in innovative pedagogy (Redecker and Punie 2017).

Participants' reflections also support broader calls for human-centered and ethically responsible AI in education, as highlighted by UNESCO (2023) and Perkins et al. (2024). While many expressed optimism about AI's potential to support pedagogical innovation, they also showed caution, emphasizing the need to integrate AI within reflective, dialogic, and learner-focused approaches, consistent with reflective teaching frameworks (Schön 1983; Brookfield 2017). It also ensures that teaching practices align with ethical and professional values.

Six key areas of pedagogical relevance were identified: (1) increased access and inclusivity, (2) fostering creativity and exploration, (3) balancing autonomy with AI assistance, (4) efficiency and personalized learning, (5) interdisciplinary and holistic learning, and (6) critical thinking and skill development. Each of these areas is explored in the following subsections, accompanied by participant reflections and interpretive commentary, illustrating how pre-service teachers are beginning to articulate a nuanced and professionally informed vision for AI in the classroom.

Increased Access and Inclusivity

A recurring insight from participants was the potential of generative AI to broaden access to music-making. Pre-service teachers noted that AI-based tools provided meaningful creative engagement regardless of their technical skills or musical experience. As one participant reflected, "Even those of us without strong musical backgrounds were able to create something meaningful. AI gave us a starting point and helped us feel part of the creative process."

Participants envisioned using these tools to design inclusive classrooms, where all learners, even those with limited instrumental skills or formal music literacy, could participate in composition and sound design. By lowering entry barriers, AI was seen as expanding opportunities for expression and creativity. These observations align with research that positions AI as a means of democratizing creative practices in education (Li and Wang 2024; Cheng 2025).

Fostering Creativity and Exploration

Participants emphasized how generative AI expanded their creative boundaries and supported artistic risk-taking. By offering immediate access to diverse musical ideas, the tools supported curiosity and experimentation with structure, mood, and instrumentation. As one participant noted, "AI made it easier to experiment without fear of doing it wrong; we could try new ideas and immediately hear how they changed the whole piece."

Used with pedagogical intent, AI was not seen as a shortcut but as a catalyst for creative autonomy, helping students move from passive consumption to active exploration. This shift aligns with the DigCompEdu framework's focus on exploratory learning and digital creativity (Redecker and Punie 2017) and supports research advocating for the role of

technology in fostering imaginative engagement and iterative learning (Cheng 2025; Li and Wang 2024). Overall, reflections suggest that when integrated into learner-centered pedagogical models, generative AI can support artistic discovery while strengthening students' confidence and reflective identities as creators.

Balancing Autonomy with AI Assistance

While participants valued the creative opportunities offered by generative AI, they also expressed concern about overreliance on algorithmic outputs. Reflections emphasized the need to preserve learner autonomy, ensuring students remain active decision-makers rather than passive recipients of AI suggestions. Many highlighted the educator's role in scaffolding learning experiences that encourage independent thinking, creative judgment, and critical evaluation. As one participant reflected, "Both methods have advantages and disadvantages. In my opinion, we can find a balance and use both processes by taking the best from each one."

This perspective aligns with Perkins et al. (2024), who advocate for frameworks that ethically and pedagogically integrate AI while protecting authorship and agency. It also reflects the DigCompEdu framework's focus on learner empowerment and reflective, autonomous practices (Redecker and Punie 2017). For teacher education, these insights are particularly relevant: pre-service teachers must learn to balance innovation with human-centered approaches, developing the capacity to integrate AI without compromising creativity, authorship, or transformative learning environments.

Efficiency and Personalized Learning

Participants' reflections highlighted the practical value of generative music AI for enhancing classroom efficiency and adaptability. Pre-service teachers noted that AI tools could assist in producing instructional materials, such as songs, rhymes, and soundscapes, while also supporting task differentiation to address diverse learner needs.

A recurring theme was AI's potential to support personalized learning. Participants suggested that generative tools could adapt guidance and feedback to students' musical backgrounds, creative preferences, and levels of engagement. Such flexibility was seen as especially useful in mixed-ability classrooms and inclusive contexts where time and resources are limited.

These insights align with the DigCompEdu framework's emphasis on learner empowerment through the innovative use of digital technologies (Redecker and Punie 2017). More broadly, they illustrate how AI can serve as a pedagogical partner in both creative work and instructional planning, strengthening formative assessment and responsive teaching when embedded within intentional, student-centered pedagogies.

Interdisciplinary and Holistic Learning

Pre-service teachers recognized the potential of generative AI to support interdisciplinary learning by connecting music, literature, visual arts, and drama. Reflections described how

AI-enabled processes connected musical elements with storytelling, visual creation, and performance, fostering artistic dialogue across domains.

Participants envisioned classrooms where students engage with multiple disciplines simultaneously, developing conceptual understanding through multimodal expression. Rather than treating music as a stand-alone subject, they approached it as part of a broader communicative and aesthetic experience. AI tools were seen as catalysts for collaborative exploration and meaning-making, reflecting arts integration principles that emphasize co-constructing knowledge through artistic and curricular connections (Silverstein and Layne 2010).

These perspectives also resonate with research highlighting music's role in holistic development, emotional expression, collaboration, and reflective thinking (Barrett and Welch 2021), and with Kertz-Welzel's (2017) argument that the arts deepen learning by bridging affective and cognitive domains. When paired with thoughtful pedagogy, AI-supported interdisciplinary projects were perceived as promoting inclusion, engagement, and cultural awareness, while simultaneously strengthening digital fluency and expressive diversity.

Critical Thinking and Skill Development

AI integration was not viewed as an endpoint, but as a catalyst for engagement, critical dialogue, and artistic growth, underscoring the need for intentional, scaffolded use in teacher education. Participants valued approaches that combined critical thinking with the development of technical and creative skills. Rather than accepting AI-generated outputs passively, they emphasized opportunities for students to experiment with musical form, structure, and instrumentation, using AI as a springboard for inquiry and reflection.

Creative tasks encouraged learners to question the artistic value of AI contributions, make informed decisions, and refine their ideas in response to technological input and peer feedback. As one participant explained, "AI helped with ideas, but we still had to think about what made sense musically; it pushed us to justify our choices and not just accept what it gave us." This iterative process fostered deeper musical understanding alongside metacognitive skills such as evaluation, justification, and revision.

When embedded within reflective pedagogies, AI was seen as a tool that can sustain inquiry and exploratory thinking—capacities essential in technology-rich environments. These insights highlight how arts-based, interdisciplinary practices can cultivate both digital and creative literacies, preparing future educators to integrate AI in ways that are critical, inclusive, and pedagogically meaningful.

Taken together, participants' reflections illustrate how generative AI can act both as a catalyst for creativity and as a source of pedagogical tension. While it broadened access, fostered experimentation, and supported interdisciplinary collaboration, concerns around authorship, autonomy, and overreliance highlighted the need for careful guidance. These dual perspectives set the stage for the following discussion, where implications are drawn for teacher education, digital competence, and the integration of AI within reflective, arts-based pedagogical models.

Discussion

This study examined the integration of music-generative AI in interdisciplinary artistic projects with pre-service teachers, focusing on its role in professional learning. Using an interpretive, exploratory methodology, the findings offer insight into how digital tools can both support and challenge pedagogical development.

Participants described AI tools as catalysts for creative experimentation, collaboration, and inclusive participation. For many, especially those with limited musical backgrounds, it lowered technical barriers and opened new pathways for artistic engagement. These experiences align with Cheng (2025) and Li and Wang (2024), who highlight AI's potential to democratize creative practices and reflect DigCompEdu dimensions of creativity, learner empowerment, and collaborative knowledge building (Redecker and Punie 2017).

At the same time, participants voiced concerns about authorship, autonomy, and dependence on algorithmic suggestions. These concerns echo Milhano's (2024) call for authorship in arts-based teacher education. This study extends that work by exploring how human–AI collaboration reshapes agency and pedagogical intent in interdisciplinary contexts.

The cross-disciplinary design provided a rich setting for integrating creativity and pedagogy, aligning with calls for ethical, human-centered uses of AI (Cadima et al. 2024). Through multimodal co-creation, participants explored evolving relationships between technology, creativity, and educational purpose.

Ethical framing and guided reflection were key parts of the study. Participants became increasingly aware of authorship, authenticity, and data ethics issues, supporting Perkins et al.'s (2024) argument that educators must develop digital ethics and assessment literacy to understand the implications of AI.

Together, these findings show how thoughtfully engaging with AI can foster reflective learning, creative independence, and interdisciplinary thinking. They emphasize the need for teacher training that goes beyond technical skills to promote the ethically grounded use of digital tools. While models like TPACK and SAMR expand the discussion, DigCompEdu provides a competency-based approach that better supports reflective and creative practice.

The project's design also highlighted challenges: students had to adapt to unfamiliar technologies and group dynamics, and some needed extra support. This emphasizes the importance of inclusive, flexible teaching methods and aligns with Brookfield's (2017) argument that critical reflection is a key part of teacher learning.

AI acted both as a catalyst and as a constraint: it broadened access and experimentation, while non-AI approaches fostered deeper collaboration and artistic ownership. This duality is captured in the conceptual model (Figure 1), where pre-service learning is framed at the intersection of AI integration, creative pedagogy, digital competence, and professional development.

Implications and Recommendations

Participants' reflections highlighted both opportunities and risks to teacher education. AI-lowered technical barriers and encouraged participation, yet raised concerns about authorship, autonomy, and overreliance on algorithms. For teacher educators, dual-mode projects, working both with and without AI, promote comparison, reflection, and awareness of how technology reshapes creativity and identity. For curriculum designers, embedding AI-supported arts tasks in interdisciplinary modules ensures sustained collaboration and reflection. For policymakers, adapting DigCompEdu to emphasize collaboration, reflection, and creativity, especially Areas 1 and 3, would help translate competences into practical strategies that balance pedagogy, ethics, and inclusivity.

At the pedagogical level, this study also informed institutional recommendations. These stress transparency (disclosing AI use), inclusive access, and critical reflection on how AI reshapes agency, creativity, and pedagogy. They call for gradual, structured integration supported by scaffolding tools such as the AIAS scale (Perkins et al. 2024).

Nonetheless, limitations must be acknowledged. This study was exploratory, embedded in a Portuguese institutional context, and focused on a single arts-based curricular unit. Implementation required teacher facilitation, structured reflection, and digital infrastructure, conditions that may not be equally available elsewhere. Scaling such approaches requires professional development, flexible curricula, and supportive policy frameworks.

Future studies should broaden the analytical lens to examine how reflective and creative uses of AI compare with approaches prioritizing efficiency or technical skills. It should also explore cross-curricular collaboration, adaptable assessment strategies, and interdisciplinary professional development models that promote the creative and ethical application of AI. Such pathways can strengthen teacher identity and equip future educators to apply AI in inclusive and innovative ways.

Conclusion

This study examined how pre-service teachers engage with generative AI in interdisciplinary artistic creation during their initial teacher training. By comparing music composition experiences with and without AI, participants developed a reflective understanding of the pedagogical opportunities and challenges involved in integrating emerging technologies into creative learning environments.

Findings suggest that, when purposefully integrated, generative music AI can broaden access to music education, support inclusive learning, and encourage creative risk-taking. It acted as a creative aid rather than as a substitute for human expression, offering meaningful entry points for learners from diverse artistic and technical backgrounds.

At the same time, the study shows that these benefits depend on informed use. Concerns around authorship, authenticity, and overreliance on algorithmic outputs highlighted the

need for ethical awareness and reflective scaffolding in teacher education. The comparative design of the project helped participants articulate the value and limits of both AI-assisted and analog creative processes, strengthening their digital literacy and professional agency.

These findings reinforce the value of experiential, arts-integrated pedagogies that combine technological fluency with collaboration and critical reflection. Constructs such as learner agency, creative agency, and TCR proved central to this study's conceptual model (Figure 1), which links AI integration to pedagogy and professional learning.

More broadly, the study contributes to digital pedagogy by showing how the DigCompEdu framework can guide the adoption of tools that foster empowerment, creativity, and ethical innovation. It also informed institutional recommendations that stressed transparency, responsibility, inclusive access, and interdisciplinary pedagogy. While the findings are situated in a Portuguese institutional context, they open pathways for adaptation in broader teacher education systems. Preparing educators to engage critically with human–machine creative interplay will help ensure that digital tools support inclusive, purposeful, and transformative learning.

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Informed Consent

The author has obtained informed consent from all participants.

Conflict of Interest

The author declares that there is no conflict of interest.

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