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Generative AI as a Collaborator in Music Education: An Action-Network Theoretical Approach to Fostering Musical Creativities

Lauri Väkevä
University of Helsinki (Finland)

Heidi Partti
University of the Arts Helsinki (Finland)

Abstract

This article explores the potential of Generative Artificial Intelligence (GenAI) to enhance music education by facilitating creative collaborations. Drawing on the pragmatism of the later works of John Dewey and the posthumanism of Karen Barad, and employing Actor-Network Theory (ANT), we propose viewing creative collaborations as dynamic systems of intra-actions, transcending didactic interactions to include broader, systemic engagements. In this outlook, GenAI tests the limits of collaborative agency in educational settings. Yet, although GenAI can enhance musical learning and evolve within these processes, we question its potential to educate due to its limitations in ethical deliberation. This questioning raises significant implications for music educators, underscoring the need for pedagogical tact in AI-assisted educational environments.

Keywords

Artificial intelligence (AI), Creative collaboration, Posthumanism, Pragmatism, Music education

A common general definition of creativity portrays it as the imaginative capacity to generate ideas, products, or solutions that are both novel and useful within a specific context (Cropley 2023). While creativity has often been attributed to individuals, it is also increasingly recognized as a quality of exchanging and developing ideas in a shared context (Barrett, Creech, and Zhukov 2021; John-Steiner 2006; Paulus and Nijstad 2019). Instead of one creativity, there has been growing discussion about different creativities, within music education and beyond (de Bruin, Burnard, and Tavis 2018; Randles and Burnard 2023). In addition, technologies are increasingly acknowledged as mediating creative collaborations (Audry 2021; Dillon 2003; Jeong and Hmelo-Silver 2016; King 2008; Muukkonen et al. 2005; Partti 2014; Partti and Karlsen 2010). This poses the question of technology's dual capacity as both a creative and collaborative entity.

Collaboration is often conceptualized as a dynamic interaction among agents working to fulfill a shared objective within specific socio-cultural frameworks (Yong 2020). Thus, historically, the narrative of creative collaboration has centered around intentional agents capable of meaning-making—individually or collectively (Eteläpelto and Lahti 2008; Gaggioli et al. 2011; Sawyer 2017).[1] This overlooks the roles played by non-intentional agents in mediated interactions.

As Barrett, Cheech, and Zhukov (2021) observed, researchers have lately extended creative collaboration to encompass "interactions between creator and audiences, materials, embodied actions, and the historico-socio-cultural affordances of the creative activity and environment" (2). This perspective seems to allow non-intentional actors to participate in the collaborative process, challenging the anthropocentric biases traditionally associated with creative endeavors.

Dewey's pragmatism and Barad's posthumanist philosophy can help further challenge anthropocentric views, as both suggest that creative collaboration may emerge in systems of action where non-intentional agents play a significant part. Pragmatism, as developed by Dewey in his later works (e.g., Dewey 1996b/1925/LW 1, 1996e/1938/LW 12; Dewey and Bentley 1996/1949/LW 16), highlights the emergent and transactional nature of meaning formation, whereas the posthumanist philosophy, in the form developed by Barad (2003, 2007), reconceptualizes non-human entities as active participants in it. While there are differences between these views, together they help to shift the focus of studying collaborative creativity from the actions of intentional agents to the relationships

in which creative collaboration emerges.[2] They also suggest that intentionality might be considered an emergent phenomenon, dependent on the dynamics of the action of the collaborating agents (cf. Jacob 1997).

In the ensuing discussion, we utilize actor-network theory (ANT) to develop further the underpinnings of these philosophical frameworks for music education, focusing specifically on integrating Generative Artificial Intelligence (GenAI) in creative contexts. Despite the differences between these frames of reference, we see them as attempts to solve similar questions, questions that relate to the ontological role of semiotic (meaning-making) agency in making sense and how human and non-human agencies are entangled in it. We also claim that all of them can be used in developing a philosophical understanding about how digital technologies are involved in human-world-relationships. We specifically delve into the role of GenAI as a creative force and its potential within educational actor networks, focusing on its capacity to function as a collaborative agent absent intentionality. We also scrutinize the capabilities of GenAI to facilitate learning, growth, and *Bildung* (self-cultivation) amidst creative musical endeavors.[3] After this, we will interrogate the feasibility of GenAI playing the role of an educator and broaden our exploration to encompass the temporal dynamics that characterize the interplay of human and machine creativities, opening up new creative possibilities in music education. The prospect of GenAI forging novel educational trajectories is contingent upon its ethical application, which necessitates oversight by human educators to leverage its pedagogical potential. This further requires formulating a framework of an educator's pedagogical tact attuned to the complexities presented by AI in educational contexts—a framework that should be both inherently ethical and critically aware of the creative opportunities and challenges posed by it.

Generative AI as a Creative Force

GenAI epitomizes an advanced form of artificial intelligence that emulates human-like creativity. In music, prime examples include but are not restricted to, such music-generating platforms as Suno.[4] GenAI is also capable of adopting diverse roles typically occupied by humans, ostensibly fostering dialogical interactions (Hohenstein et al. 2023). For example, students can use AI tools to develop their ideas for musical compositions, engage in real-time improvisation, or receive feedback on the timing, pitch, dynamics, etc., of their music performance to help them

refine their technique or expression. The effectiveness of GenAI is rooted in machine learning, an ability to evolve through exposure to vast pre-training data guided by models, viz., algorithmic frameworks tailored to enhance information processing for distinct purposes. By incorporating advanced machine learning techniques, including deep learning, or learning that occurs across multiple layers within neural networks, GenAI approximates human capacities for generating ideas, designs, and artistic works, as can be witnessed in various creative domains (Audry 2021; Ivcevic and Grandinetti 2024; Koivisto and Grassini 2023; Voigts et al. 2024; Zhou and Lee 2024; Zylinska 2020).

Several commentators have proposed that GenAI can revolutionize how to think about the role of technologies in creativity (Audry 2021; Epstein et al. 2023; Verganti, Vendraminelli, and Iansiti 2020). There is a growing consensus that AI heralds an era where digital technologies are integrated seamlessly into daily creative workflows, including in the arts, design, research, and development (Anantrasirichai and Bull 2022). This integration is exemplified by the emergence of semi-autonomous AI assistants collaborating directly with human creators (e.g., Gabriel et al. 2024; Gates 2023).

The increasing application of GenAI in creative fields has sparked new research and development in the AI field, with a heavy investment in designing more advanced models that can further push the boundaries of machine creativity. This initiative extends beyond Large Language Models (LLMs), which primarily produce textual or spoken content, to encompass Multimodal Large Language Models (MLLMs). These advanced models are capable of handling varied data forms and converting content from one medium to another, unlocking new potential for automated content generation across the arts and other creative disciplines (Yin et al. 2023).[5]

The expanding capabilities of GenAI models have also led to increasing concerns about the potential for these systems to displace human creatives, particularly as the so-called fourth industrial revolution or second machine age gains momentum (Brynjolfsson and MacAfee 2016; Schwab 2016). Fears have emerged regarding significant job losses in creative professions, challenging human artistic authorship (Artist Rights Alliance 2024; Lee 2022). Issues surrounding the safeguarding of creator rights and the use of copyrighted material in pre-training AI necessitate robust protocols and transparent practices to alleviate its dangers as "an extractive industry" (Crawford 2021, 15). AI-specific ethical considerations

also include such issues as data protection, transparency, reliability, and strategies to avoid reproducing biases and discrimination (Bouhouita-Guermech, Gogognon, and Bélisle-Pipon 2023; UNESCO 2023). The utilization of GenAI technologies heightens the necessity of the ability to recognize and critically evaluate the implications of applying these technologies in creative pursuits.

Environmental sustainability concerns have also been raised due to the considerable computing power required by GenAI (AI and Compute 2018; Kirkpatrick 2023; Patterson et al. 2021). In addition, it has been reported that the pre-training and maintaining of GenAI models exploits low-income labor force and violates the fundamental human rights and freedoms of those performing this work (Tan and Cabato 2023), contributing to the ethical complexities associated with their development and deployment. There is also an increasing alarm over using GenAI for unethical political purposes, such as influencing electoral outcomes by creating deepfake videos and cloned voices (Masood et al. 2023). Many experts assert that these issues should be a focal point of discussion across all sectors employing GenAI, with a particular emphasis on their implications in educational settings (Deckers and Lara 2023; UNESCO 2023). The discourse surrounding the integration of GenAI into music education must also critically address these multifaceted concerns and recognize the ethical complexity involved.

Overall, the rapid expansion of GenAI's creative capacities raises the question of whether digital technology has reached, or maybe is on the verge of reaching, a level of agency comparable to human intelligence. However, this would seem to require much more than what current models can offer. Yet, some industry experts argue that the current iteration of narrow, task-specific GenAI is setting the stage for the emergence of Artificial General Intelligence (AGI)—a robust form of AI capable of tackling a broad spectrum of problems in ways that are human-like or even superior, and even develop conscious thought (MacAulay 2023).[6] While the attribution of human-like intelligence and consciousness to AI may be premature because of its algorithmic principle of operation (Korteling et al. 2021), it is undeniable that GenAI is reshaping how non-human agents are perceived in creative processes (LeDoux et al. 2023). This technological change opens new avenues for conceptualizing creative agencies within collaborative environments that accommodate both human and non-human actors.

Considering GenAI as a potential creative-collaborative force is also timely in music education, a field traditionally reliant on human involvement but increasingly subject to technological transformation. For instance, GenAI offers new possibilities for deliberating how technologies mediate musical creativity, which can be seen in the increasing use of AI tools in musical composition and production (Owsinski 2023). Increasingly, GenAI tools are being deployed in the creation of music in "hybrid teams"—teams "of multiple agents that interdependently work together, and where agents can be either humans or machines" (van den Bosch et al. 2019, 573).[7] This prompts a broader question: Is technology progressing to a stage where it acts not just as a mediator but presents itself as a semi-independent agentive force that could potentially offer educational value? More pointedly, the evolution of GenAI compels music educators to explore the following questions: What roles might this technology assume within musical learning environments and communities? Should it be merely regarded as a teaching and learning tool, or does its adaptability and learning capability warrant a degree of autonomy, positioning it as a partner in musico-pedagogical practice? Addressing such questions is crucial for developing music education programs that fully leverage the advancements in GenAI. It is also essential to adopt a critical approach to examining the questions and implications associated with ethics and sustainability to grasp its broader implications.

GenAI as a Networked Actor

To effectively explore the role of GenAI in music education, it is important to understand the nature of the agency we are dealing with when incorporating it into educational settings. One productive method for examining the agency of GenAI is through ANT, which provides a framework for analyzing the interactions and influences of various *actants* within interconnected systems of action (Latour 1996, 2005; Sayes 2014).[8]

According to Latour (1996), an actant is "something that acts or to which activity is granted by others" (7). This characterization of actants underscores that they do not necessarily require "any special motivation" (7), or intention to be involved in action networks. ANT focuses on how meaning is collaboratively created within dynamic networks, challenging the traditional view that only intentional agents can convey or create it.

In the domain of music studies, ANT has been utilized to examine the ways in which technology facilitates musical creativity. It suggests that technological actants not only support but actively shape musical outcomes, for instance, in digital audio production and sound design or AI-assisted performance and composition (Asplund 2022; Born and Barry 2018; Kim-Boyle 2008; Krogh 2018). This perspective invites teachers and students to reconsider music as a system composed of networked actants, including non-human actants. There is also a philosophical implication; ANT challenges the anthropocentric position that views music as an exclusively human endeavor and music education as an interaction solely among human participants (see also Piekut 2014). Such an expansion in the conceptualization of who or what can participate in musical creativity suggests that it does not occur solely among humans but also within dynamic networks where human and non-human agents interact. This reconceptualization also allows us to explore new models of educational practice that integrate GenAI and other technologies as active participants entangled in the pedagogical process.

Due to its adaptability and semi-autonomous capabilities, GenAI presents a compelling case for exploring how non-human actants can shape musical creativity in actor networks. As previously mentioned, GenAI has been increasingly implemented in processes and workflows of musical creation, and this technology seems to be capable of fulfilling many functions previously thought to be possible only for human beings—though many industry experts still regard human involvement as indispensable in music-making (Artist Rights Alliance 2024; Owsinski 2023). The potential for GenAI to alter this dynamic in the future is an open question, but our current inquiry is more focused: What specific roles can GenAI play in music education, particularly in contexts that require creativity? This invites us to examine the possibilities for GenAI not just as a tool or facilitator but as an active collaborator in the creative processes.

The Performative Agency of GenAI

One approach to understanding how GenAI can engage creatively in actor networks within music education and other pedagogical domains is *performativity*. In the philosophy of language, performativity refers to the capacity of language use to effectuate actions that bring about meaningful occurrences (Austin 1962/2009; Loxley 2007). For Austin (1962/2009), any linguistic act that enacts an action—

such as the utterance "I do" during a wedding ceremony—can be considered performative. This approach suggests that performativity can be ascribed to all linguistic expressions that carry out semiotic (meaning-creating) functions within specific, action-oriented contexts, which aligns with the training objectives of LLMs.[9] However, performativity can also be expanded to non-linguistic semiotic practices; for instance, instrumental music can be examined as performative utterance, such as when a wedding march signals the beginning of a nuptial ritual (Davidson 2014; Kartomi 2014).

Performativity theory has also been adapted to education, guiding us to view pedagogical environments as scenes where performative functions are enacted (Lenz Taguchi 2009; Locke 2015; Murris 2022; Väkevä 2023). In this adaptation, performativity is often connected to socio-material theories emphasizing the dynamic interplay between material and human actants in educational scenarios (Carvalho and Yeaoman 2021; Fenwick and Edwards 2013). As Lenz Taguchi (2009) notes, the posthumanist view expands the educational context to include "all living organisms and the material environment such as things, spaces, and places" (16) as educationally significant (see also Barrett, Creech and Zhukov 2021). From a posthumanist perspective, performative educational situations are thus not confined to human interactions. However, adopting this approach raises fundamental philosophical questions about the capacity of non-human agents to engage in educational practices. Can entities such as GenAI genuinely educate, or are they merely facilitating human-determined instructional activities? This questioning challenges traditional notions of what it means to educate and be educated, prompting further exploration into whether non-human agents can possess or develop the kind of intentionality and reflexivity typically associated with human educators.

Guided by the philosophical underpinnings of Deweyan pragmatism and Baradian posthumanism and maintaining a close alignment with ANT and performativity theory, we can further explore GenAI's performative power using the concepts of *actions*, *interactions*, *transactions,* and *intra-actions* (Dewey and Bentley 1996, 96–110).

Actions, as defined in this context, refer to events that produce observable consequences, irrespective of the presence of intentionality or consciousness.[10] Such events can be theoretically considered isolated, though in practical scenarios, they

are revealed to be interconnected with a series of other events. For example, striking an individual note on a piano can be interpreted as an action that, at a closer look, is influenced by a confluence of factors in real-life contexts—including the pianist's intentions, the instrument, and the environment's acoustics.

Interactions are reciprocal actions, or actions that are bidirectional between actants. Interactions are often causal, stemming from direct influences between actants, yet they may also be casual, emerging from established habits or adapted behaviors within specific contexts. For example, a music educator and a student may adjust their musical contributions in response to each other during a classroom performance, interacting both causally and habitually. Similarly, when GenAI creatively responds to a user's prompt, it can spark a new idea, demonstrating a capability of dynamic interaction. Within the framework of ANT, interactions between actants can be taken as the fundamental nodes of actor networks.

Transactions extend beyond mere interactions by involving actants in coordinated systems of interactions that constitute *situations* where actants are embedded within their environment (Dewey and Bentley 1996, 101–2). The concept of situation aligns with the Deweyan pragmatist perspective, where transactions are not just exchanges but transformative engagements that generate new possibilities for meaning-making and actively shape the contexts in which actions occur. From this perspective, transactions facilitate qualitative changes by elevating the scope of interactions to new systemic levels (Dewey 1925/1996b; Väkevä 2023). These changes are here described as qualitative because they enable entirely new *kinds* of interactions. For example, in a music education setting, a transaction might occur when a teacher and students collaboratively engage in free improvisation, forming new ideas that lead to the emergence of new creativities (see also Randles and Burnard 2023).[11]

Further exploration into performativity is enriched by the concept of *intra-actions*, introduced by Barad (2003, 2007) within the framework of agentive realism—an agentive ontology that underscores the significance of relationships between all kinds of agents involved in semiotic activities. Intra-actions can be characterized as the forces that propel actions, interactions, and transactions across various system levels; animate and inanimate, intentional and unintentional, conscious and nonconscious, human and non-human. Barad's theoretical framework emphasizes the constitutive role of intra-actions in shaping both the semiotic processes and the actants involved. This shift from a state of "being" to

the process of "becoming" highlights the dynamic and evolving nature of relationships between entities, as well as the entities themselves (Barad 2007). Barad's perspective aligns with pragmatist event ontologies, such as those proposed by Dewey (1925/1996b) and Buchler (1966/1990), where even the most seemingly stable objects are revealed as processes (see also Alexander 2013; Margolis 2022, chapter 4; Whitehead 1929/1978). By integrating the concept of intra-actions, the study of performativity in educational and other contexts becomes an examination of how actants are not merely acting, interacting, and transacting, but continuously formed and reformed through their relational transactional engagements.

Music education can also be viewed as a dynamic performative network constituted by actions, interactions, transactions, and intra-actions occurring at various systemic levels. For instance, new creativities may emerge when students utilize GenAI-based tools to learn and compose music innovatively in a teacher-facilitated learning environment (see Holdhus, Christophersen, and Partti 2022). In such scenarios, imposing rigid boundaries between human and non-human actants is often unnecessary. From a posthumanist viewpoint, the demarcations between actants are not fixed but are continuously reshaped as intra-actions at different levels of activity constantly generate new possibilities for meaning. This ongoing semiotic process allows the actor networks to adapt to changing circumstances, echoing the pragmatist concept of forming habits, which can be interpreted as a performative process.

The cooperative dynamics within actor networks, driven by intertwining agentive forces, can be further conceptualized as constituting *field events*. The term "field" in this context refers to the inclusive situation wherein the coordination of human and non-human agencies takes place, subsequently leading to new solutions for specific situational challenges (Dewey 1938/1996e). Dewey (1938/1996e) labels this process of seeking solutions *inquiry*, considering it fundamental to all intelligent efforts of meaning-making. He describes inquiry as a "directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (Dewey 1938/1996e, 108)—a process that not only provides more efficient ways to adapt to the word but also introduces new qualitative possibilities of experiencing this adaptation.

Methodologically, adopting a pragmatist-posthumanist perspective necessitates a holistic approach to studying music education. Within this framework, various actions, interactions, transactions, and intra-actions converge, collectively generating new meanings. Thus, a music educational situation is reconceived not merely as a didactic interaction between teacher and student or as a case of an educator transmitting knowledge and skills to learners, as in classical didactic theories (see e.g., Ryen 2020). Instead, it is viewed as a complex environment where numerous actants join in performing meaning, only some of which are within the educator's control. This broader view emphasizes the multiplicity of agents at play, underscoring the dynamic nature of all education.

Accepting that technological agents like GenAI can perform meaning within actor networks raises further questions about the actual collaborative capacity of such technologies. As an algorithmic operator, can GenAI work alongside other agents, human or otherwise, to create something meaningful? Can it align with human agents to pursue a shared objective or even manifest its own purposiveness? These queries not only probe the functional capabilities of GenAI but also lead us deeper into a critical examination of the potential roles non-human agents might play in educational contexts, touching the core of contemporary educational theory, which we will discuss in the following section.

To wrap up at this point, exploring whether GenAI can collaborate in education involves rethinking established notions of pedagogical situations. It challenges us to consider if the traditional teacher-student dynamic should be extended to include non-human entities that can adapt, respond, and potentially guide learning processes in the field events of actions, interactions, transactions, and intra-actions.[12] This inquiry invites a broader philosophical debate about agency, collaboration, and knowledge creation within current educational systems. Such considerations may be timely as they can reshape our understanding of music education in an increasingly connected world.

GenAI as a Collaborator of Learning, Growth, and *Bildung*

Setting aside momentarily the question of whether GenAI can fulfill an educational role, it is beneficial to focus on how performative action unfolds within actor networks that facilitate education. We will next explore the concepts of *learning*,

growth, and Bildung as performative field events integrated within musico-pedagogical contexts.

Learning, growth, and *Bildung* can be referred to as "process terms" because they do not inherently seem to require deliberate educational agency (Siljander 2015). Theoretically, they can take place without the direct influence of an educator, for instance, in such informal settings as garage rock bands or online music communities (Partti 2012; Väkevä 2010). However, this perspective does not necessarily imply that all these processes can occur entirely without human intervention. Yet, our approach can perhaps help illuminate the various ways in which both human and non-human agents can contribute to educative situations, particularly in contexts where GenAI and traditional human-led pedagogical practices intersect.

Learning can be conceptualized as any change that equips agents to sustain agency in future scenarios. This perspective posits that learning involves a capacity to adapt, which necessitates some form of feedback mechanism and the ability to store, retrieve, and utilize information. However, this concept of learning does not necessarily involve intentionality, except in the basic sense that the agents are oriented towards learning.[13] In this context, GenAI and other technological entities can be seen as learners in their own right, capable of adapting to change based on the information they process—for instance, when a GenAI music-generation model learns to create music in a more human-like way. This broadens the traditional view of learning to encompass a variety of agents, highlighting the diversity of the adaptations that contribute to the educational process.

Growth, as conceptualized by Dewey (1916/1996a), builds upon learning by introducing an intentional aspect of being cognizant of the continuity between situations, thereby implying a capacity for *judgment* regarding how learning may lead to future adaptations. This concept of growth necessitates recognizing the continuity between present circumstances and future possibilities, suggesting a requirement for some form of imaginative capacity. AI might or might not be able to develop this imaginative capacity because the latter requires at least a rudimentary appreciation of *value*, enabling the judgment of what should be pursued or avoided. While growth in this context is intentional—a "cumulative movement of action toward a later result" (1916/1996a, 46)—it remains an open question whether it requires intentional states of consciousness.

For instance, a GenAI system might exhibit growth by enhancing its capacity to anticipate future situations, even if it lacks imagination, awareness of the underlying processes, or reasons for its adaptations. An AI-powered virtual tutor exemplifies such growth with its ability to track the student's progress, adjust its recommendations, and suggest further exercises based on the cumulative learning of the student. Such a system possesses a forward-looking orientation and a degree of autonomy in bridging temporal contexts, enabled by the sophisticated multilayered modeling capabilities that allow it to manage uncertainty to some extent (Chaki 2023; Hansen 2015). For such a system to grow, it might be sufficient that it can transform the conditions of its own present agency to future possibilities of acting by making more and more successful predictions based on what it learns in situ. Some scholars even proposed that similar predictive abilities might constitute the fundamental building blocks of human intelligence (Clark 2023; Seth 2021), suggesting a parallel between human cognitive processes and the functionalities of advanced AI systems. However, such approaches seem to fall short of explaining how imagination, and thus creativity, figures into such predictive schemas of intelligence.[14]

Bildung, as employed here, derives from the German humanist tradition and denotes a lifelong process of self-cultivation through which individuals evolve into ethically autonomous members of their societies. Here, "autonomous" does not imply isolation but rather the capacity to make independent decisions while considering the decisions of others (Siljander 2015; Sjöström and Eilks 2021). This concept extends beyond learning and growth, emphasizing synchronization with the accepted ways of living within a society, a concept historically referred to by German thinkers of the 19th century as *Sittlichkeit* (Jessop 2012; Kosnoski 2010). However, *Bildung* also transcends mere socialization or enculturation into the prevailing norms by incorporating critical reflection that enables individuals to evaluate the potential impacts of their actions against their society's established values but also to question these values when necessary (see e.g., Klafki 1998; Ryen 2020). This critical reflection, which Dewey described as *deliberation*, can be considered a hallmark of ethical behavior (Dewey 1932/1996d).[15]

From this viewpoint, it appears that agents cannot fully navigate the complex cultural and ethical terrains that define social life without engaging in *Bildung*. This further suggests that human-like agents are uniquely positioned for *Bildung*, as they alone (as far as we know) can develop the capability for ethical deliberation

and critical reflection based on their creative ability to imagine future situations. Before non-human actors can learn and grow in ways that are ethically responsible and recognizable to human standards, they remain distinct from this transformative process (Siau and Wang 2020; cf. Martinho, Kroesen and Chorus 2021; Tække and Paulsen 2022). Thus, while non-human actors like GenAI may be involved in learning and growth, their involvement in *Bildung*, with its ethical and cultural dimensions, poses significant challenges.[16]

These three process terms imply different levels of relationships within actor networks conducive to music education, with implications for considering GenAI as a creative and collaborative agent capable of performing meaning.

Learning, as previously outlined, can take place in any transaction where new coordination among actants is established, bearing potential significance for future situations. Fundamentally, learning enhances an actant's or actor network's ability to adapt to a changing environment, regardless of whether this adaptation involves conscious awareness. As evidenced by machine learning, GenAI can effectively adjust to change in ways that parallel human capabilities, for instance, learning to generate more human-sounding music. Furthermore, deep learning aims to mimic the complexity of human cognition by digitally replicating neural connections, which is evident in the increasingly human-like creative behaviors exhibited by GenAI models, even if their operational principles often remain veiled. If teachers embrace such a broad definition of learning, they can conclude that GenAI models learn just as effectively as any other actants. This is also relevant in the context of music education, where GenAI can participate alongside students in the musical learning environments as co-learners, facilitating collaborative endeavors that mediate the actor networks encompassing humans and machines. In this way, allegedly, GenAI not only can contribute to students' learning but also to adapt and evolve in response to their actions.

Growth, as defined earlier, entails the deliberate coordination of actions aimed at cumulating future adaptations. This process is intentional in that it is directed toward more beneficial adaptations and thus presupposes an awareness of the continuity between present and future scenarios. It also implies a sense of value, which may not necessarily be conscious. The question of whether GenAI can develop such value-imbued expectations remains unresolved (see e.g., Johnston 2023). Be that as it may, the adaptive and semi-autonomous capabilities of the latest-generation GenAI models exhibit basic human-like abilities to weigh options, for instance, in

the case of AI-assisted instrument practice sessions or AI tools providing personalized and gradually progressing feedback for student composers. Such capacities could potentially be interpreted as rudimentary signs of the ability of AI to judge value as a basis of growth, even if we have no proof of its imaginary capabilities. However, current technological developments still necessitate human oversight to ensure that the growth of AI aligns with acceptable goals—a requirement likely to persist as long as the norms of ethical behavior continue to be primarily human constructs. Despite predictions about the advent of AGI, there is no concrete evidence that AI systems can possess a human-like ability to project values into the future beyond algorithmically navigating toward predefined goals. In music education, this means that GenAI may not be able to collaborate in the musical growth of the students beyond elementary regulation of the means-ends continuum.[17]

Bildung, as previously outlined, hinges on the ethical co-dependence between individuals and collectives, necessitating the ability for ethical deliberation. This deliberation enables actors to recognize situations that require specific attention and determine the appropriate behavior in particular circumstances and environments, along with considering the rationale behind these decisions. The question of whether GenAI models, even when aptly mimicking human behavior, can ever truly enact *Bildung* revolves around their capacity to coordinate their learning and growth in alignment with the conduct of ethical actors and to critically deliberate on the potential consequences of their own and others' choices in light of invested values (Martinho, Kroesen, and Chorus 2021). Currently, such critical capabilities seem beyond the reach of existing and near-future AI technologies. For GenAI models to genuinely exhibit ethical conduct, they would need the capacity to encounter situations requiring ethical deliberation and engage in such deliberation creatively against the backdrop of the value systems of contemporary and potential future societies. This involves navigating *moral uncertainty*, a concept that reflects the complexity of ethical decision-making in varied and evolving contexts (MacAskill, Bykvist, and Ord 2020). Arguably, developing such sophisticated ethical behavior requires a process of *Bildung* characterized by continuous learning and dialogue with other moral agents. While it might be conceivable that such processes could one day be simulated by AI, its current technological capabilities do not yet support this level of complex, adaptive, and ethically nuanced functioning (cf. Martinho, Kroesen, and Chorus 2021). To collaborate in music education con-

ducive to *Bildung*, then, GenAI needs to be regulated by human beings, acknowledging that it is a human product that mirrors the preferences and biases of its developers.

Even if GenAI is incapable of facilitating and being subject to *Bildung*, the pivotal question remains: Can it educate? The answer depends on how we define education and its relationship to *Bildung*. The standard English dictionary definition of education is quite broad, encompassing all forms of teaching and upbringing activities, from animal training to child-rearing, as long as they facilitate learning (see e.g., OED 2024, s.v. *education*). This expansive definition might suggest that GenAI can educate, even without pedagogical intentions. However, the situation becomes more complex when we consider specific definitions of education. In the German pedagogical tradition, which has significantly influenced continental educational theories, *Erziehung* (education, fostering, or upbringing) is often seen as *Doppelgänger* for *Bildung*, implying that these concepts may be interdependent; one cannot become self-cultivated without education, and vice versa (Benner 2023; Siljander 2015; Uljens 1997). This tradition suggests that education involves not just the transmission of knowledge and growth but also the cultivation of ethical, reflective, and critical capacities, which requires transformation. Under this interpretation, because non-human agents like GenAI cannot provide the ethical sounding boards necessary for individuals to become reflective, critical, and responsible members of society, they cannot deliberately educate—not in musical or any other situations. While GenAI may assist in learning and even contribute to growth (and learn and maybe grow itself), its inability to facilitate the development of ethical agents implies a fundamental limitation in its educational capacity.

To summarize this section, it seems that GenAI can act as a co-learner and may even undergo growth alongside human agents within music education contexts. However, whether its growth extends beyond mere algorithmic adaptation to future situations remains debatable. If growth requires imagination, teachers must consider whether GenAI possesses creative projective capabilities. Although GenAI systems might develop the ability to represent probable future situations for adaptation, this does not necessarily mean they can envisage improved futures, at least not without human guidance. The prospects become even less promising when considering learning and growth within the socio-cultural sphere, where values need to be judged against ethical principles. GenAI appears incapable of engaging in such processes at any level of independence, as it requires pre-training,

fine-tuning, and prompting to adapt to even relatively simple social situations. Unless ethical deliberation can be algorithmically modeled—a possibility that currently seems beyond the scope of existing or foreseeable technologies—GenAI's capability to learn and grow in ethically significant ways remains limited. Thus, while GenAI may contribute to music education, its role in fostering the deeper, value-driven aspects of *Bildung* within educational settings seems to be fundamentally constrained. This means that it cannot 'perform' in a very convincing manner in such contexts.

Implications of Considering GenAI as a Creative Collaborator in Music Education

Based on the preceding discussion, musical-educational scenarios may be conceptualized as field events characterized by the dynamic interplay among various actants engaged in networked interactions, transactions, and intra-actions to generate new meanings and to support learning, growth, and *Bildung*. In such contexts, AI can participate in learning processes alongside human actants despite its inability to intend to do so or to grasp the meanings of what is learned. GenAI exemplifies an advanced form of algorithmic but self-regulating agency, distinguished from earlier intelligent machines' enhanced capacity to adapt flexibly to new situations. Yet this adaptation, as it stands, necessitates human intervention to be educative.

As the self-regulating capabilities of GenAI evolve, there is potential that this technology can refine its predictive abilities, thereby improving its efficiency in responding to complex situations. Such advancements may eventually facilitate a more synchronized developmental trajectory between human learners and AI, enabling them to work in educational contexts collaboratively in hybrid teams, for instance by developing new curricular goals and teaching methods. In this scenario, the boundaries between human and machine learning processes become increasingly integrated. Deweyan pragmatist and Baradian posthumanist perspectives, along with such systemic approaches as ANT, help us to investigate the shifting liminalities emerging from multiple-level intra-actions that constitute the actor networks of human and non-human actants.

While GenAI can participate in the creative pursuits in such actor networks, aiding itself and other networked actants in managing uncertainty, its capacity to

educate—particularly in a manner that fosters *Bildung*—remains a contentious issue, to say the least. This limitation primarily stems from AI's inability to deliberate ethically. Currently, the complexities of moral uncertainty seem to be too intricate for intelligent technologies. This appears to restrict AI from fulfilling educational roles that require ethical considerations. Nevertheless, as previously noted, GenAI can still play a significant part in educational contexts. It can act as a participant and potentially even as a collaborator of learning and, possibly, growth, even if it does not extend its agency to the value-driven processes of supporting *Bildung*.

What prerequisites would be necessary for enacting effective human-to-machine creative collaborations within educative actor networks in musical settings? According to van den Bosch et al. (2021), to optimize cooperation between humans and AI in "hybrid teams," several challenges should be addressed (580):

- *Shared Vocabulary*: It is essential for both humans and AI actants to have a common language that facilitates communication about actions and intentions.
- *Shared Mental Models*: Both parties must establish cognitive frameworks that enable them to predict and interpret each other's behaviors.
- *Role and Self-awareness*: Each team member must have an understanding of their own roles and the roles of others.
- *Adaptive Interaction*: Collaboration should foster adaptive interactions that evolve based on a mutual understanding of the context.
- *Sustained Learning and Improvement:* Continuous feedback loops and learning mechanisms should be integrated to constantly enhance team performance.
- *Effective Communication*: AI agents need to be capable of expressing their states and needs in a manner that is comprehensible to human partners, and vice versa, to avoid misunderstandings stemming from differing vocabularies.

These challenges highlight the need for GenAI to advance beyond mere language use and role fulfillment—capabilities at which it already excels—to develop some kinds of projective or intentional states. As previously noted, such capabilities currently lie beyond the reach of existing AI technologies. This limitation is underscored by a fundamental ontological difference: humans experience intentional, subjective, and conscious states, whereas AI seems to be fated to operate without such inner life.

Moreover, there might be a significant discrepancy in how humans and machines experience and operate temporally, suggesting a fundamental difference in their abilities to direct to the future. This discrepancy might also have musical implications. Ernst (2013) argued that digital machines and humans handle time in fundamentally different ways, which has consequences for how they can collaborate in creative endeavors. While digital machines are unable to model the richness of phenomenological experience (e.g., shades of feeling), they exhibit a unique kind of temporality that introduces a new non-linear form of time that Ernst called "tempor(e)ality" (Ernst 2013, 29–31). This notion of a non-linear form of digital time can be attributed to have musical implications, for Ernst (2013, 31, 144) elaborated on this concept using the notions of "tonality" and "sonicity" to describe how tempor(e)ality is embedded in digital infrastructure in a non-linear fashion, reshaping our traditional understanding of time as a succession of moments (see also Ernst 2016). The non-linear nature of sonicity potentially disrupts conventional understandings of knowledge, as digital signals flow freely through media channels, allowing them to be explored as material rather than semiotic processes. In these material processes, claimed Ernst, sign(al)s are liberated from their linear temporal constraints and become polytemporal, enabling a new digital mode of experiencing where they are constantly available for recall and recycling. This musical free-form digital processing allegedly creates new temporal spaces where human performativity can meet AI algorithms, resulting in a synchronous rather than narrative sense of time filled with polytemporal repercussions, or what Miyazaki (2018, 244) called "algorhytmic" events, or "timing effects of computation."[18]

Traditional narrative structures, therefore, may fall short of capturing the essence of digital creativity as digital processes transcend linear temporal frameworks, manifesting new algorhythmic possibilities. This perspective suggests that digital machines operate on a distinctly non-linear temporal plane, comprehensible to humans only retrospectively. If this is true, it might be idle to demand them human projectivity: their intentional capacities might be based on entirely different logic than the logic of representation, maybe more akin to musical expression.

Another perspective on the distinction between human and AI creativity involves recognizing *qualities* inherent to human experience that are arguably absent in the algorithmic processes. In the realm of machine learning-based art, Audry (2021) discussed how traditional algorithmic AI predominantly adheres to a computational dogma centered around formal, rule-based systems. Audry contrasts

the operation of these first-order systems with the second-order adaptive and evolutionary systems that operate in distinct temporal frameworks due to their capacity to self-regulate without human intervention. Examples of such systems include AI installations and robot musicians guided by machine learning. Thus, while some GenAI systems demonstrate the ability to regulate their behavior through continuous adaptive feedback cycles, suggesting a capacity for learning, others can develop novel action patterns, leading to new "outstanding transformations" (Audry 2021). Here adaptation is not merely about performing better within pre-programmed parameters, which means that performativity cannot solely be evaluated based on how the previous learning of these systems helps them anticipate future operational needs. As they are perpetually in search of new patterns, they are also able to generate new situations and perform new forms of creativity. Audry (2021) posits that such second-order technological systems herald new aesthetic spaces to be explored together with human and machine actors. Presumably, the emergence of such systems rewards attention from the side of art(s) educators, including music educators.

What do these insights suggest about the educational potential of GenAI as a creative collaborator in music education? Can it function as an educational partner in musical-artistic contexts that foster the development of new aesthetic sensibilities despite the operational differences between machine and human agencies and its inability of ethical deliberation? Can the interplay of human and machine temporalities facilitate new musical creativities characterized by polytemporal and multilateral algorhytmic flows of signals? Is it possible for GenAI to introduce new forms of expressive agency that transcend traditional musical forms? These questions probe the depth of GenAI's potential in reshaping creative practices. They also challenge us to consider whether GenAI can not only participate in but also significantly transform music education by introducing novel dynamics into the transactions conducive to musical growth and *Bildung*. The capability of GenAI to act autonomously and adaptively in creative processes suggests a potential to redefine the parameters of musical exploration and education, potentially enabling it to function not just as a tool but as an artist in its own right. It might be wise not to overlook this possibility in music education, especially when recognizing that GenAI is already shaping how music is created, shared, and experienced (Sturm et al., 2024).

Conclusion

The integration of GenAI in music education for the enhancement of creativity poses a distinctive challenge: How do we guarantee that it fortifies educational outcomes while simultaneously enriching creative processes? This question mirrors a more profound conundrum faced by modern educational theory: How is it possible to foster freedom through structured guidance (Kant 2004/1900, 27)? This paradox, which many educators view as inherently irresolvable (see e.g., Schaffar 2014; Siljander 2015), suggests that for individuals to be cultivated into autonomous personalities, they require an education that promotes *Bildung*. The dialectic relation between *Bildung* and education underscores the complexity of implementing GenAI in educational settings where the goal is not merely to impart musical knowledge or develop musical skills but to facilitate deeper, more personal growth through creative artistic engagement. Thus, the challenge lies in configuring GenAI not just as a tool for musical learning but as a catalyst for human development within the framework of *Bildung*.

While GenAI may never be able to collaborate in advancing *Bildung* in a human-like manner, it holds vast potential to enrich art-educational experiences by fostering new forms of creativity. Realizing this potential may necessitate more developed machine autonomy that ushers novel tempor(e)alities by creating spaces where human and machine perceptions of time intersect. Even then, integrating GenAI into educational situations require ethical deliberation, or what van Manen (2015) describes as "pedagogical tact"—the readiness of the educator to act optimally for the benefit of the students in moments when complex educational situations arise. In practicing such tact, music educators must be able to identify and navigate the ethical ramifications of employing GenAI, ensuring that it contributes positively and sustainably to learning environments designed to promote creativity, critical reflection, and ethical deliberation. Such careful stewardship is essential to harness GenAI's capabilities responsibly, aligning technological innovation with the ethical values that guide educational practice. Practicing such tact should also recognize the relevance of user-end training GenAI models. Such user-end training may require both context-specific prompting and personalizing these models for specific use cases in music education and beyond. From the teachers, it requires sensitivity towards recognizing the ways GenAI models operate, and a readiness to supervise their operation in pedagogical situations in ways that are

responsive to various demands for sustainability—ecological, social, cultural, economic, and aesthetic.

GenAI's potential to engage in and even transform artistic creation heralds new possibilities for artistic expression and, thus, also music education. GenAI has the capability to produce innovative outputs that could challenge and expand our traditional conceptions of musical creativity—and, as suggested by Ernst (2013, 2016), maybe even challenge our understanding of temporality. However, while GenAI may drive significant artistic innovation and introduce new musical creativities, its tactful facilitation is essential to ensure that educational values remain at the forefront. Such oversight helps us to balance innovative technological capabilities and the demand for ethical integrity that supports all meaningful art(s) education.

Despite limitations in its intentional capacities, the evolving autonomy of GenAI points to a future where it might more independently conceive and execute artistic ideas, transforming creative agencies into new forms. Again, the ramifications of this growing autonomy demand scrutiny and guidance by educators to ensure alignment with value-based objectives. Educators need to ensure that the deployment of GenAI supports rather than detracts students from educational aims and ethical standards, which requires critical reflection on its operating principles while also recognizing its risks (e.g. in reproducing biases, inequalities, and discrimination as well as exacerbating the ecological crisis). While GenAI can potentially become a valuable asset in music education, significant questions persist regarding its ability to contribute meaningfully to fostering students' ethical growth and *Bildung*. The degree to which GenAI can fulfill an integral educational role will hinge on its further development and educators' deepening understanding of its capabilities and restrictions.

In conclusion, the potential of GenAI to serve as a creative collaborator in music education elicits both enthusiasm and caution. Integrating such technologies into educational settings must be governed by ethical consideration, pedagogical integrity, and a commitment to educational value goals. This also suggests a need to evolve pedagogical and didactic theories that are responsive to the rapid advancements in GenAI. It is crucial to recognize that technological enhancements do not supplant the fundamental human commitment required to advance learning and growth towards *Bildung*. In human life, these are all social-cultural processes centered around sharing (rather than just making) meaning, which relies on

human interaction and the capacity for sustained ethical deliberation. While GenAI presents exciting possibilities for expanding musical learning environments to pedagogical contexts, it must be deployed in a manner that supports and enhances these processes as parts of the educational endeavor.

About the Authors

Lauri Väkevä is currently working as a Professor of Didactics of Crafts and Arts at University of Helsinki, Finland. He has previously worked as a Lecturer, Professor, and Vice-Rector at the University of the Arts Helsinki and as a researcher at the University of Oulu. His research interests cover crafts and arts education and didactics with a special focus on music education, popular culture, educational philosophy, instructional technology, and the sociology of education. He has published and lectured widely in these fields.

Heidi Partti works as a Professor of Music Education at the Sibelius Academy of the University of the Arts Helsinki, Finland. Her approach to music education encompasses a strong interdisciplinary perspective. Her research primarily centers around issues of creativity, eco-social sustainability, and ethics in a post-digital society. She teaches research ethics and provides guidance for master's theses and doctoral dissertations. She actively collaborates within international networks and projects, and frequently delivers lectures beyond the realm of academia.

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Notes

[1] The concept of intentionality harbors a dual interpretation: a commitment to an action course and the capacity to represent or stand (Magalhães and De Araujo 2022). Philosophical debates continue over whether all agents following an action course necessarily possess intentional states (see e.g., Baker 2007; Brandom 2001; Churchland 1989; Dennett 1978).

[2] When Dewey and Barad are discussed together, their anti-dualistic tendencies are often highlighted. For instance, Fischer (2018, 83) has examined both as a "recourse to a philosophical tradition spanning the better part of 200 years," and maintains that both are "similarly equipped with the resources and tools needed for dealing with shortcomings identified by the … new materialist critiques." Barad's agentive realism has also been used in reading Dewey through the lenses of feminist philosophy (see e.g., Thiel and Sant 2024). In addition, Barad's philosophy has been characterized as "feminist naturalism" (Rouse 2004), which, in our reading, is not that far away from Dewey's "cultural naturalism" (see also Väkevä 2023).

[3] According to Herdt (2021), *Bildung* can be understood as "ethical formation, development, education, or culture." We define it as a cultivation (development, improvement) process that takes place at both individual and cultural level, but it can also be understood as a cultural product, or an outcome of such a cultivation process. We will later discuss its relation to education.

[4] GenAI can be used for a wide variety of purposes, including journalistic, coding, and artistic generation. Here, we focus on the kind of GenAI typically used in musical contexts and discuss its potential in music education.

[5] For instance, in October 2024, the above-mentioned music generation tool Suno added functionality called Suno Scenes, which allowed its mobile app users to "take a picture or use a photo from your camera roll to create a 30-second song" (Create Music with an Image 2024), Similar media-transforming functionalities have been introduced in image and video generating tools in recent years.

[6] A well-known example of affirmative position regarding the potential consciousness of AI was the case of Google engineer Blake Lemoine, who made headlines (and got fired) by claiming that LaMDA, the chatbot he had been testing, was sentient (Tiku 2022). Other AI developers and researchers who have made similar claims include Ilya Sutskever (2022), the chief scientist of the OpenAI research group, and philosopher Nick Bostrom (Jackson 2023).

[7] In April 2023, a research report from music distribution company Ditto Music stated that 59.5% of professionals are already using AI to create music, while a

further 47% were inclined to use AI for songwriting in the future (Parsons and Heteringhton 2023).

[8] A seminal text formulating the basic tenets of ANT is Latour (1987). For examples of how ANT has been used in music studies, see the special issue 37 of *Contemporary Music Review* (2018). From the standpoint of ANT, one can also argue that musicians have always been part of networks interacting with technological tools; hence, this perspective transcends the digital milieux of music-making.

[9] Performativity of LLMs has been studied e.g., from the specific standpoint of how their bias is revealed in gendered language use (Gross 2023). Here we will discuss more generally the possibility that LLMs can be studied as performative agents in educational situations.

[10] Dewey and Bentley (1996, 101) used originally the term "self-action" instead of "action", indicating that "things are viewed as acting under their own powers." Here we use the term "action" in a more extensive sense, referring to an event that can also have consequences. One could also say that defined in this way, actions are at least potentially performative.

[11] Transactions have also been discussed in educational philosophy (Biesta 2010; Biesta and Burbules 2003) and the sociology of music (Rimmer 2024). The concept of transactions can thus be applied in a wide variety of approaches, unified by a motivation to consider action holistically and systemically. Fischer (2018, 88) observes that "a Deweyan, naturalistic conception of the transacting self inhabiting the world can constitute, for feminists, a model of anti-dualistic theorising that conceives of nature and culture … in less antagonistic and mutually accommodating terms," and uses this concept in tandem with the Baradian concept of intra-actions. We recognize the difference between these two concepts while acknowledging the similar motivation behind their construction.

[12] Such an expansion can also be described by a didactic tetrahedron, where technology is considered as an actant relevant to reciprocal regulation of the relationship between the teacher, student, and subject matter (Tall 1986). However, as indicated above, we suggest a more expansive portrayal of educational intra-actions as networked systems of activity, where traditional didactic positions and roles are not that clear-cut (see also Rezat and Sträzer 2012; Dasari et al., 2024).

[13] This perspective of learning could perhaps be interpreted as related to information processing theory. However, we use the term in more extensive sense, as indicating a possibility of change in the conditions of agency of a system capable of reacting to its environment. Such approach to learning relates to theories that accept the adaptive nature of all learning, whether it involves naturally evolved or designed systems.

Väkevä, Lauri, and Partti, Heidi. 2025. Generative AI as a collaborator in music education: An action-network theoretical approach to fostering musical creatives. *Action, Criticism, and Theory for Music Education* 24 (3): 16–52. https://doi.org/10.22176/act24.3.16

[14] In principle, imagination could maybe be explained as a predicting ability based on internal modeling of possible scenarios that any neural network, natural or artificial, can learn. However, as we will argue below, educational problem-solving seems to involve an added ingredient of ethical deliberation, which, according to Dewey, is a requirement for intelligence in action. Whether creativity always requires imagination is a matter of argument; here, we follow a lead that it might not in the case of intelligent machines.

[15] Dewey described deliberation as forming a practical judgment that guides action to resolve some predicament. Deliberation is also a means of transforming individual behavior into mutual understanding, agreement, and collective action and, thus, a cornerstone of a democratic way of life (Dewey 1996d/1932/LW 7).

[16] One could perhaps also say that, merely acting in the role of an actant, as described by ANT, does not give an actor agency capable of ethical deliberation, as the emergence of such an ability requires the kinds of transactions that entail actors to become responsible for their own actions.

[17] For Dewey (1996d/1932/LW 7), a necessary condition for ethical conduct is the ability to judge both means and ends contextually, keeping an eye to the possible alignment of choices with socially and culturally accepted values. Considering the balance of means and ends also makes possible their critical reflection, which might be outside the scope of AI technology.

[18] Miyazaki (2018, 244) further describes algorhythms as "time-based, technological processes, which occur when matter is modulated by symbolic and logical structures, such as instructions written as code."