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A Resonant Learning (RL) Framework

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Abstract
This paper introduces the *Resonant Learning* (RL) framework, building on Hartmut Rosa's sociological theory of resonance and Graham Wallas' theory of the creative process. The RL framework aims to contribute to teacher education by delineating *resonant learning spaces* in an increasingly digitally-mediated post-digital educational landscape. This paper suggests that the RL framework has potential to enhance teaching and learning by integrating principles of *resonance*, *second-order resonance* and *creativity*. The research aligns with the growing need to focus on Creativity, Innovation, and Entrepreneurship (CIE) and Maker Education (ME) with the use of Information and Communication Technology (ICT) in education. The *laptop orchestra* (LO) is discussed as a model resonant learning space that facilitates CIE & ME. This study highlights the significance of RL in supporting pre-service teacher training by fostering *ICT efficacy*, *agency*, *creativity*, and *digital competencies* essential for future-oriented pedagogy.

Keywords: Education, Resonant Learning, Creativity, Teacher Training, Laptop Orchestra, ICT, CIE

1. Introduction

Digital tools – including computers, portable electronic devices (PEDs), and platforms that digitally-mediate learning – are reshaping teaching and learning (Ghory & Ghafory, 2021; Crawford, 2017; Wise, 2016; Wise et al., 2011; Savage, 2007). According to Merrick and Joseph (2023), the integration of digital tools in education is accelerating, presenting challenges and prompting educators to adapt by leveraging Information and Communication Technology (ICT). These developments necessitate "new approaches to learning" underpinned by "innovative pedagogy" (Merrick & Joseph, 2023). However, even though many educators employ ICT in the classroom, it is largely used for administrative tasks as opposed to pedagogical purposes (Merrick & Joseph, 2023). As Onwuegbuzie and Collins (2007) note, "few teachers integrate ICT in a way that motivates students and stimulates higher-level thinking." This issue highlights a critical gap between the potential of ICT in education and its pedagogical application in the classroom. This gap is also recognized by Ertmer and Ottenbreit-Leftwich (2010) who point out that while teachers may have access to digital tools, the lack of knowledge about effective integration strategies often results in their limited use in teaching. Similarly, Inan and Lowther (2010) found that insufficient professional development and a lack of confidence in using technology hinder teachers from fully

embracing ICT in practice. As educators must now navigate a rapidly evolving post-digital educational landscape, there is a need to develop *resonant learning spaces* that focus on Creativity, Innovation, and Entrepreneurship (CIE) in teacher training (Papageorgiou & Kokshagina, 2022, Barneva et al., 2021).

Drawing on Hartmut Rosa's theory of *resonance* and *alienation* this paper presents the Resonant Learning (RL) framework using Graham Wallas' theory of creative process (1926/2018). *Resonance* relates to a positive, dynamic interaction between individuals and their environments, while *alienation* refers to a disconnect and lack of engagement (Rosa, 2019). The RL framework expands on Rosa's (2019) discussion of resonance and alienation in schools by addressing the role of digital technologies in educational spaces and emphasizing creativity. It aims to contribute to the development of post-digital educational spaces that account for the transformative dynamics of digital technologies in the classroom. Laptop orchestras (LOs) are examined as model post-digital RL spaces where teachers' and students' "co-presence(s) in multiple spaces" are localized while using digital tools (Carvalho & Freeman, 2023; Fawns, 2019; Lamb et al., 2022). In such *spaces*, social experiences and connections to the world are characterized by "new distributions of activity across time, space, media, organizations, and people" (Carvalho & Freeman, 2023; Carvalho et al., 2017). Carvalho and Lamb (2023) highlight that "underlying this perspective is a view of learning that goes beyond traditional representations." By moving beyond the general use of ICT to CIE teaching approaches the RL framework aims to account for the 'co-presence' of being and learning in 'multiple spaces,' characteristic of post-digital education.

This study highlights the importance of developing *resonant learning spaces* in facilitating collaborative learning environments, enhancing technical skill acquisition, and fostering future-oriented pedagogy. RL spaces, such as LO, can foster *ICT efficacy*, *agency*, *creativity*, and *digital competencies*. Research supports "that increased levels of computer self-efficacy can lead to higher levels of confidence in being an efficient teacher with ICT" (Merrick & Joseph, 2023; Hatlevik & Hatlevik, 2018; Fanni et al., 2013). These elements are critical in equipping future educators with the skills necessary to navigate the rapidly evolving educational landscape. By emphasizing resonance and creativity, the RL framework aims to provide a systematic way to innovate teacher education.

2. Key Concepts

To present the three main sections of this article:

Section 3: Resonant Learning – Understanding Learning through *Resonance*
Section 4: Teacher-Student Resonance, Alienation and *Burnout*
Section 5: From ICT to CIE – Creativity Transforming Music Education by Facilitating Resonant Learning Through Laptop Orchestra

It is helpful to define and contextualize four critical concepts discussed in this article: 1) *ICT in music education,* 2) *CIE learning*, 3) *laptop orchestra (LO),* and 4) *resonance* and *alienation*.

2.1. Information and Communication Technology (ICT) in Music Education

Information and Communication Technology (ICT) is defined by the United Nations Educational, Scientific and Cultural Organization as a "diverse set of technological tools and resources used to transmit, store, create, share, or exchange information" (UNESCO, 2021). In music education, ICT generally refers to using digital tools and resources to enhance the teaching and learning process for teaching and administrative purposes. Merrick and Joseph (2023), in their study on examining educator perspectives using music technology, expand on the definition of ICT to include "any existing or emerging digital device or tools, the use of hardware and/or software and/or web-based applications in any way to support learning about, the creation of, and the performance of music" (Merrick & Joseph, 2023; Merrick, 2017). In secondary school music education, ICT encompasses various technologies like music production software, digital instruments, and online learning platforms. Although many publications reference the various uses of ICT in learning (King et al., 2017; Ruthmann & Mantie, 2017), Merrick and Joseph (2023) explain that only a limited number of studies have explored the *usage* and integration of ICT in music education. They suggest that "there is a growing need to understand teachers' perceptions, integration,

and engagement with ICT through pedagogy and learning to enhance professional practice." Likewise, Eyles (2018), Partti (2017), and Savage (2007) emphasize the importance of comprehending how ICT can be effectively integrated into music education to address the evolving needs of learners. Ouyang (2022) in their study suggested: "that integrating an interactive learning environment" through mobile apps "into a music classroom positively affects student performance," and data collected showed that an "interactive learning environment encourages students to attend classes regularly" (Ouyang, 2023). Merrick and Joseph (2023) further highlight that in an era where students are "digital natives" routinely "immersed in mobile devices" and rapid technological advancements (Leong, 2017), many teachers face a significant challenge. With limited or no training in ICT, teachers often struggle to keep up with the pace of technological change. This discrepancy underscores the necessity for educational practices to evolve; as Partti and Westerlund (2013) emphasize, "teaching practice and professional learning should reflect current developments in digital and virtual technologies." Understanding these perspectives is essential for advancing music pedagogy with ICT in secondary school music classrooms.

2.2. Creativity, Innovation, and Entrepreneurship (CIE) Learning

Papageorgiou and Kokshagina (2022), in their book *Envisioning the Future of Learning for Creativity, Innovation, and Entrepreneurship*, define CIE as "three intertwined competencies" involving 1) the generation of novel and valuable ideas (*creativity*), 2) the intentional introduction and application of these ideas to benefit individuals, groups, or society (*innovation*), and 3) the discovery, evaluation, and exploitation of opportunities with the confidence to act on them (*entrepreneurship*).[1] CIE education strongly connects with STEAM (Science, Technology, Engineering, Arts, and Mathematics), project-based learning (PBL), and Maker Education (ME) approaches. Both CIE and STEAM/PBL/ME emphasize interdisciplinary, hands-on approaches that encourage students to engage actively in their learning through real-world applications. Papageorgiou and Kokshagina (2022) explain that CIE emphasizes multidisciplinary problem-solving, risk-taking, and action-oriented mindsets focusing on "developing transformative competencies." It embodies a holistic approach to learning that transcends disciplines and prepares learners for lifelong learning and adaptability in "uncertain environments" (Ibid, 2022). CIE learning spaces emphasize the notion of "learning by doing, being in real-world environments and embracing experimentation (and failure)," which is crucial for learning (Ibid, 2022). The authors stress that creativity, innovation, and entrepreneurship are interconnected, and CIE learning fosters attitudes, skills, and processes relevant to a "future-ready learning landscape" (Ibid, 2022).

2.3. Laptop Orchestra (LO)

Laptop Orchestras (LOs) are technology-mediated musical ensembles that use laptops as primary instruments for music-making, often incorporating live coding, digital signal processing, and electronic music production techniques (Wang et al., 2008). The definition of LO has evolved to include other portable electronic devices (PEDs) like tablets, smartphones, and custom controllers. Laptop orchestras stem from early ensembles like the League of Automatic Composers and The Hub, who pioneered networked computer music performance in the late 1970s and early 80s (Bischoff et al., 1978; Trueman, 2007). Dan Trueman, who is a co-founder of Princeton Laptop Orchestra (PLOrk), defines LO as an ensemble of laptops and associated human performers where each performer plays a laptop through a personal speaker sphere "that allows for omnidirectional, variable radiation of sound (inspired by the way traditional orchestral instruments work)" (Trueman, 2007). Ge Wang, another co-founder of PLOrk, who later founded the Stanford Laptop Orchestra (SLOrk) in 2008, in a co-authored article titled *The Laptop Orchestra as Classroom* (Wang et al., 2008), explain that the LO "provides the specifics and hands-on examples needed to transfer concept into practice." The authors also illustrate the flexible learning spaces: "If the rehearsal-hall classroom setting represents the training ground of PLOrk (Princeton Laptop Ensemble), the studio classroom serves as the "trenches." In the context of a LO classroom, Wang et al. (2008) describe two primary educational settings: 1) a larger rehearsal hall and 2) a smaller studio space. These two distinct environments play different but complementary roles in the learning process. The rehearsal hall serves as a space where students come together for large-scale ensemble practice and collective exploration, much like a

[1] The term "entrepreneurship" should be understood as a form of emancipated creativity, taking creativity into one's own hands and being able to develop an idea and make it accessible, in other words "materializing creativity".

traditional orchestra hall. In contrast, the studio classroom functions as the "trenches," which describes a more focused, hands-on environment where students engage with technological tools and individual work.

2.4. Resonance and Alienation

Hartmut Rosa's concept of *resonance* is central to understanding the subtleties of human relationships with the world and each other. In his book *Resonance: A Sociology of Our Relationship to the World* (2019), Rosa distinguishes four elements of resonance: 1) *af←fection*; 2) *e→motion*; 3) *transformation*; and 4) *unpredictability* (Rosa, 2019). In *affection* (inward arrow), *resonance* can be exhibited when an individual is affected by something external. It is when the world touches or moves us (Ibid, 2019). An illustration of this can be seen when a student is inspired by a piece of music they hear in a classroom. *Emotion* (outward arrow): after being affected by the external, the individual responds outwardly with emotional engagement. This can be observed in a student expressing joy, curiosity, or wonder while playing or listening to music. The *transformation* element is an interaction between the subject and the world (external) that leads to a change in both – the subject is transformed through the experience, and the world is perceived differently (Ibid, 2019). For example, students who initially struggle with music improvisation practice over time and gain *confidence*; this newfound skill transforms their perception of themselves as musicians and alters their understanding of music, making improvisation a fundamental part of their creative expression. Rosa (2019) explains, "resonance certainly is not just consonance or harmony; quite the opposite." Transformation requires encountering differences or opposition, as the student must overcome challenges for self-transformation. The element of *unpredictability* holds that the interaction between the individual and the world remains ambiguous and cannot be fully controlled. Rosa suggests that *true resonance* cannot be forced. Rosa's concept of alienation contrasts with resonance, describing it as a state where individuals feel detached or disconnected from the world and others. Rosa argues that alienation occurs when there is a lack of meaningful, reciprocal relationships, leading to feelings of isolation and estrangement.

The concept of *resonance*,[2] as theorized by Hartmut Rosa, can be integrated into educational frameworks to highlight its essential role in the *learning process*. This paper posits that learning environments should not merely be places of information transmission but designed as *spaces of resonance* where students feel a deep, meaningful connection to the content, educators, peers, and the material. In such environments, learning can transcend knowledge acquisition and become an experiential process where students are informed and *transformed*. Resonance in this context of learning is crucial because it fosters a dynamic interaction between the student and the subject matter, making the learning process responsive, alive, and vivid – in other words, making the learning process more *palpable* "(of a feeling or atmosphere) so intense as to seem almost tangible" (Oxford English Dictionary, 2024). Students engaging in a resonant learning environment are more likely to feel motivated, involved, and develop of higher-order critical thinking and creativity.

[2] An animated figure of *resonance*, titled '**Visualizing Resonance (v1.0)**' can be found at: https://doi.org/10.6084/m9.figshare.25999657.v1. The visualization functions as a dynamic representation of how *resonance* can *emerge* from the complex interplay of the four elements. Each element is represented by a sphere within a four-set Venn diagram. The spheres – representing *affection*, *emotion*, *transformation*, and *unpredictability* – continuously grow, shrink, and move, representing the non-static and evolving nature of these elements and our emotional states. This dynamic movement suggests that the conditions for resonance are not fixed but vary over time and context in everyday experiences. As the spheres move and change size, they intersect and overlap in various combinations, visually demonstrating how different pairings or groupings of these elements can interact. Each overlap area could potentially lead to different forms or degrees of *experience*, depending on which elements are interacting. At the center of the diagram, the word "Resonance" appears and fades; its visibility is directly tied to the intersection of all four spheres (i.e., the four elements of resonance). This *emergence* of "Resonance" occurs only when *all* elements overlap. This is the uncertain and special alignment needed for *resonance* to occur. The intermittent appearance of "Resonance" in the diagram, sometimes lasting briefly and other times more prolonged, illustrates the *transient* and often fleeting nature of *resonance* in human experience (White & Wilde, 2024f).

3. Resonant Learning – Understanding Learning through Resonance

Creating *resonant learning spaces* where students feel understood and supported can significantly affect student overall academic success. This section examines the role of *resonance* in the *learning process*, emphasizing its importance in fostering an effective educational environment. Wallas' (1926/2018) four periods of the creative process in teaching and learning are applied through Rosa's (2019) *resonance* theory and the concept of personal *transformation*. Resonance involves a deep, responsive engagement with the world, characterized by the four elements discussed in the section above. Wallas' four periods of the creative process, also known as the *Art of Thought*, include 1) *preparation*, gathering information and resources; 2) *incubation*, subconscious processing of the information; 3) *illumination*: the 'aha' moment or insight; and 4) *verification*: testing and refining the idea or knowledge (Wallas, 1926/2018). The table below introduces the fundamental principles of *Resonant Learning (RL)*.

Table 1: The four states of resonant learning (RL), Rosa's four elements of *resonance*, and Wallas' four periods of the *creative process* (White & Wilde, 2024a).

Resonant Learning (RL)	**Rosa - *Resonance***	**Wallas - *The Creative Process***
State 1 – Engagement	*Affection*: being affected by external stimuli.	*Preparation*: gathering information and resources.
State 2 – Reflection	*Emotion*: responding emotionally to these stimuli.	*Incubation*: subconscious processing of the information.
State 3 – Moment of Awe	*Transformation*: changing through these experiences.	*Illumination*: the 'aha' moment or insight.
State 4 – Application	*Unpredictability*: embracing the unexpected.	*Verification*: testing and refining the idea or knowledge.

The first state, **Engagement**, involves being affected by external stimuli, where learners gather information and resources, aligning with Wallas' *preparation* stage and Rosa's concept of *affection*. The second state, **Reflection**, focuses on the emotional response to these stimuli, corresponding to Wallas' *incubation* stage and Rosa's element of *emotion*, where the subconscious information processing occurs. In the third phase, **Moment of Awe**, learners change through their experiences, experiencing the 'aha' moment or insight described in Wallas' *illumination* stage and Rosa's idea of *transformation*. The fourth phase, **Application**, involves embracing the unexpected and applying theory to practice, aligning with Wallas' *verification* stage and Rosa's notion of *unpredictability*. This integration of *resonance* and *the creative process* highlights the dynamic correlation between emotional engagement and cognitive development in learning. The relationship of these states can be illustrated with a four-set Venn diagram showing how elements of *resonance* interconnect with Wallas' periods of the *creative process* in the *Art of Thought* (Wallas, 1926/2018).[3]

[3] An animated diagram, titled '**Phases of Resonant Learning - Resonance & The Creative Process (v1.0)**' can be found at: https://doi.org/10.6084/m9.figshare.26003509.v2. This diagram aims to illustrate that the learning phases are characterized by 'flow states,' and that learning is not a linear progression but rather an evolution stemming from the complex interactions between various conditions or 'states of being' (White & Wilde, 2024e).

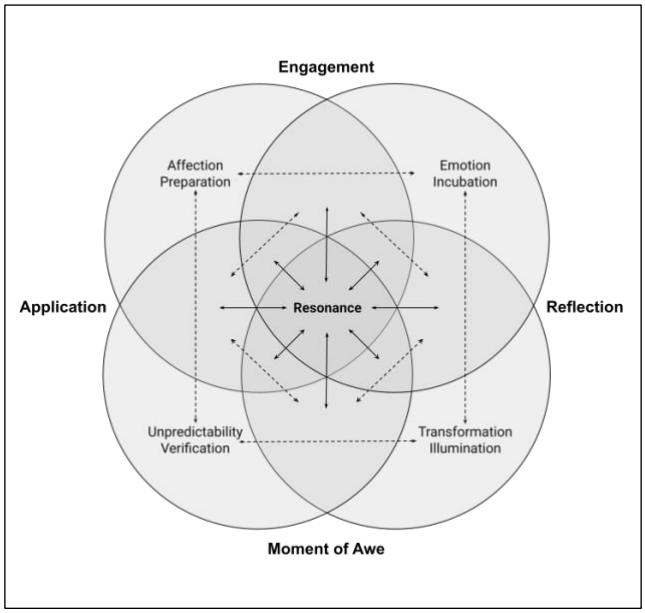

Figure 1: Four-set Venn diagram illustrating the relationship between 1) Rosa's theory of *resonance*, 2) Wallas' four periods of the *creative process*, and 3) the concept of *resonant learning*. The arrows illustrate the 'flow states' (White & Wilde, 2024d).

3.1. Engagement with the Material

Wallas' creative process emphasizes the importance of engagement at each phase. During the preparation period, students gather and interact with new information. In the incubation period, they subconsciously process this information and experience various emotions, leading to moments of illumination where new ideas can emerge. The verification period involves critical engagement and testing of these new ideas, ensuring their validity and practical application.

3.2. Emotional and Cognitive Development

Rosa's concept of resonance highlights that emotional engagement is crucial in the learning process. Learning experiences that evoke joy, curiosity, and wonder drive deeper engagement and personal transformation. A student who feels emotionally connected to a topic is more likely to engage deeply and retain information. Similarly, Wallas' creative process highlights the importance of emotion, particularly during the illumination phase, where students often experience sudden insights. This 'aha' moment is crucial for overcoming challenges and discovering solutions to complex problems. Emotional traits such as curiosity or resilience in the face of failure are essential for creative thinking and cognitive development.

3.3. Unpredictability and Creativity

According to Rosa, 'true resonance' involves unpredictability and openness to new experiences. In the classroom, *resonant learning* then requires an environment where students can explore and discover without rigid constraints. Wallas' creative process also underscores the importance of unpredictability in creativity. The verification and illumination periods, characterized by sudden understandings or breakthroughs, necessitate an environment where students can freely explore ideas, allowing for unexpected and creative solutions to emerge.

3.4. Second-order Resonance in Education

Rosa and Rüpke (2024) introduce the concept of *second-order resonance*, which refers to the more nuanced, enduring form of resonance that is not directly tied to the immediate impact of an experience but rather to the long-term relational and dispositional frameworks that enable 'first-order' *resonance* (i.e., genuine, unpredictable,

authentic, true) to occur. Rosa and Rüpke (2024) acknowledge that genuine or authentic resonance cannot be manufactured or guaranteed; *second-order resonance*, however, can be cultivated through practice.

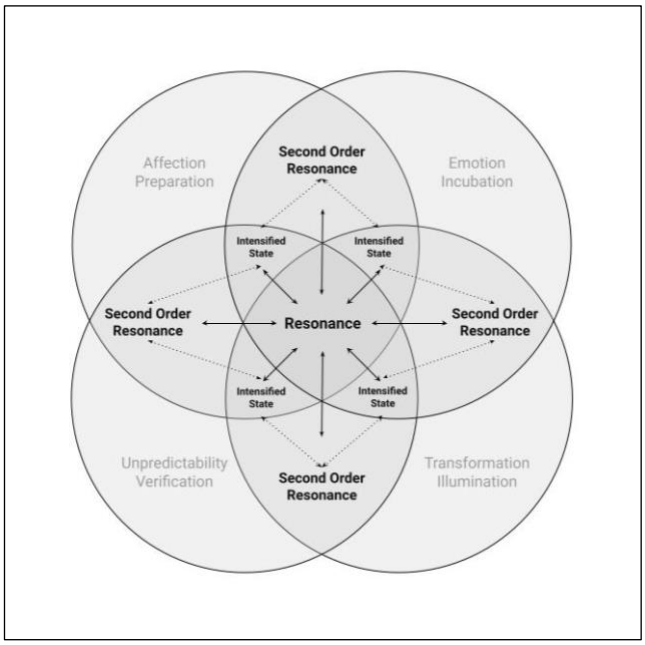

Figure 2: Four-set Venn diagram illustrating *second-order resonance*, the *intensified state(s)*, the arrows represent the 'flow states' between 1) second-order resonance, 2) intensified state(s), and 3) resonance (White & Wilde, 2024c).

Figure 2 illustrates the concept of *second-order resonance*.[4] Rosa and Rüpke (2024) explain that while moments of resonance "cannot be forced instrumentally," they can be revisited or restimulated through the memory of previous peak experiences, creating *second-order resonance*. In the Figure 2, the light grey spheres represent general elements (or periods according to Wallas): Affection-Preparation, Emotion-Incubation, Unpredictability-Verification, and Transformation-Illumination. These foundational emotional, cognitive, and perceptual states establish the conditions for potential resonant experiences. They are the broad conditions under which individual experiences and reactions occur, preparing the individual emotionally and cognitively for engagement. The intersection of these general elements can lead to **Second Order Resonance** (darker grey areas where the light grey spheres overlap represent the intersections of these elements). This intersection symbolizes more specific conditions where elements from each state combine to enhance the likelihood of experiencing *second-order resonance*. For instance, when "Affection-Preparation" overlaps "Emotion-Incubation," it might create a conducive environment that leads to deeper emotional engagement or *readiness* for resonance to occur. **Intensified State** conveys a heightened experience level, suggesting a more profound and impactful interaction than *second-order resonance*. The central, darkest area where all the spheres overlap represents the peak experience. This is the moment where all conditions — emotional preparation, cognitive readiness, unpredictability, and transformative potential — converge to create a profound resonant experience. This central point signifies the most intense and *memorable* encounters that profoundly affect the individual, often remembered as peak moments (Whaley et al., 2012). The fundamental notion is that while one cannot directly create these peak moments of *resonance* 'on demand,' one can cultivate an environment or a series of conditions that make such experiences more likely. Each state contributes to building a framework where moments of intense resonance can naturally emerge, facilitated by the memory and impact of past resonant experiences. Rosa and Rüpke (2024) explain that

[4]An animated diagram entitled '**Visualizing Second-Order Resonance (v1.0)**' is available at: https://doi.org/10.6084/m9.figshare.25999855.v2. This diagram seeks to illustrate how human thought and emotion can achieve dynamic stabilization through various 'rituals' or 'routines.' Such activities include attending concerts or church services, meditating, practicing a musical instrument or composing music, reading books, or watching movies. Each of these routines plays a role in shaping emotional and cognitive stability, and conditional probability of first-order *resonance* to occur (White & Wilde, 2024h).

individuals "repeatedly experience second-order touches (or resonance), that is, moments in which the memory of earlier peak moments becomes strong and vivid again." These memories can *(re)activate* the conditions for resonance when similar emotional, cognitive, and situational factors are present again, leading to what is termed *second-order resonance*.

Educational environments can be structured to *increase* the likelihood or potential for meaningful and transformative experiences to emerge. The two core principles of *resonant learning* include creating 1) ***engaging environment(s)*** (this encompasses 'State 1 – Engagement' and 'State 2 – Reflection') and 2) ***freedom of exploration*** (encompassing 'State 3 – Moment of Awe' and 'State 4 – Application'). Creating an *engaging environment* is a crucial precondition to *resonant learning* as "students must approach the material openly, with a willingness to engage with and be moved by it" (Rosa, 2019). Educators can use these principles to design learning activities that create the conditions for *freedom of exploration*. Incorporating open-ended projects, providing unstructured time for discussion and questions, and encouraging curiosity – allow for a degree of unpredictability in the classroom. Rosa (2019) further highlights the importance of *freedom* in a "successful lesson," suggesting that "Freedom from fear and anxiety is a fundamental precondition of involving oneself in resonant relationships." In such an atmosphere, students can openly engage, grow emotionally and cognitively, and develop their creativity in unpredictable and meaningful ways. Rosa writes, "Openness to resonance can only develop when the atmosphere in the classroom allows it." In Rosa and Rüpke's (2024) comparative analysis of rituals, *second-order resonance* is about creating an environment or the conditions that foster a sense of being "at home, affirmed, and alive," within educational spaces, the 'rituals' can be viewed as meaningful routines that allow for 'freedom' and 'openness' (Rosa and Rüpke, 2024; Rosa, 2019).

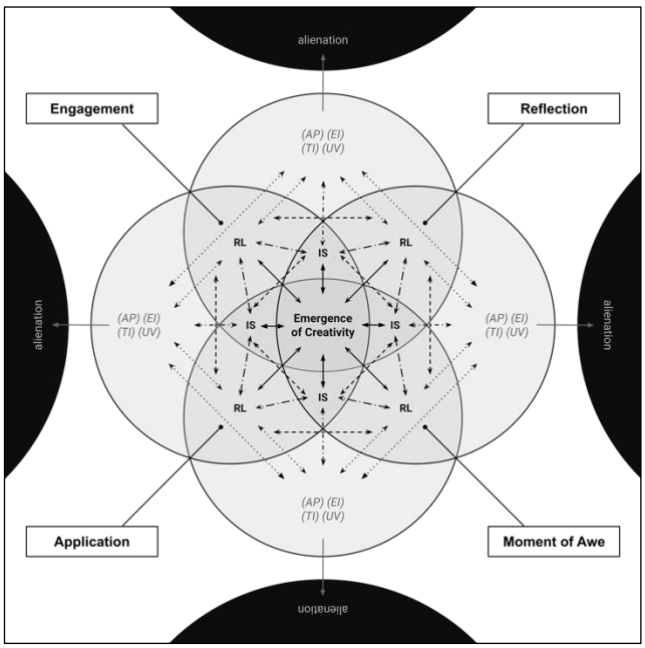

Figure 3: Diagram of *Resonant Learning* (v1.0), illustrating the four states (*Engagement*, *Reflection*, *Moment of Awe*, and *Application*) as forms of *second-order resonance* contextualized as Resonant Learning (RL), and Intensified States (IS), the 'general elements' of being are marked (AP) Affection - Preparation, (EI) Emotion - Incubation, (TI) Transformation - Illumination, and (UV) Unpredictability - Verification. Intensified States (IS). The varied density of the arrows shows the 'flow states' (White & Wilde, 2024b).

The theoretical model illustrated in Figure 3 highlights the key constructs and their interrelationships of *Resonant Learning* (v1.0).[5] It shows the emotional, cognitive, and situational states inherent in the learning process. **RL**

[5]An animated diagram entitled '**Visualizing Resonant Learning (v1.0)**' is available at: https://doi.org/10.6084/m9.figshare.26003800. This diagram aims to illustrate dynamic interplay the variable states of *Resonant Learning*, the convergence of (AP) Affection - Preparation, with (EI) Emotion - Incubation, (TI) Transformation - Illumination and (UV) Unpredictability - Verification. The diagram serves to demonstrate

(Resonant Learning) reconceptualizes *second-order resonance* as states of *resonant learning*. **IS (Intensified States),** demonstrates where multiple general elements converge, intensifying the learning experience and facilitating deeper cognitive engagement. The framework outlines the four principal states of *resonant learning* discussed earlier — *Engagement*, *Reflection*, *Moment of Awe*, and *Application* — each emerging from the intersection of the general elements: (AP) Affection - Preparation, (EI) Emotion - Incubation, (TI) Transformation - Illumination, and (UV) Unpredictability - Verification. These general states are *italicized* in the diagram to illustrate the dynamic nature and nonlinear progression in the learning process. The variable interactions between diverse emotional and cognitive conditions are depicted with arrows, indicating mupltiple 'flow states'. These arrows represent the continuous and elastic movement of concepts and insights across different phases of learning. These arrows symbolize the transitions and continuous nature of the human mind while learning. Figure 3 aims to demonstrate that the four learning states can materialize at any juncture where dynamic elements intersect, illustrating the multifaceted and complex process of learning. This means that learning states, 1) Engagement, 2) Reflection, 3) Moment of Awe, and 4) Application can occur at any intersection of the general elements (e.g., between AP and EI, EI and TI, TI and UV, or UV and AP). **Emergence/Creativity** is positioned at the center; this signifies the learning trajectory's *apex*, where knowledge and experiential insights integrate into innovative and creative thought processes. The fundamental principle of Resonant Learning (RL) is the emphasis on the emergence of creativity. Similar to the uncertain materialization of resonance, creativity cannot be 'forced' or 'guaranteed.'

3.5. Implications for Educational Practice - Teaching and Learning Strategies

The RL framework model provides a blueprint for educators to develop methodologies that support environments conducive to *resonant learning*. Understanding the interdependencies between various 'states' and 'elements' can help design educational experiences that are both engaging and have a high probability of being transformative. The framework emphasizes *spaces* where impactful learning can occur and highlights the importance of structuring educational practices that resonate with students. The practical application in education may include the following strategies:

1. *Designing a Resonant Classroom Environment - Material and Symbolic Charging*
   Similar to the example of entering a philharmonic hall (Rosa and Rüpke, 2024), where the atmosphere is charged with anticipation through various sensory cues (e.g., the dimming of lights, the tuning of instruments), educators can create a classroom environment that predisposes students to engage more *intensely*. This might involve intentionally designing classroom spaces conducive to a sense of *expectation* or *preparedness* for future events or experiences and creating an atmosphere that signals to students that meaningful and exciting learning is about to occur.

2. *Leveraging Previous High-Intensity Experiences - Building on Memories*
   Second-order resonance can be cultivated by connecting new learning experiences with past high-intensity educational moments (Rosa and Rüpke, 2024). For example, revisiting a powerful lesson or project and drawing connections to new content can renew the initial excitement and engagement.

3. *'Ritual' and Routine in Learning - Structured Repetition*
   Establishing routines, or 'ritual practices' (Rosa and Rüpke, 2024), in educational settings that students find comforting and expected can lead to greater engagement. This could include regular group discussions, project-based learning sessions, or interactive activities that become eagerly anticipated.

4. *Incorporating Agency and Interaction - Student-Centered Learning*
   Allowing students to have a say in how they learn and offering choices in their projects or assessments can enhance their sense of *agency*, an essential aspect of *second-order resonance*. This can empower students and make the learning process something they actively shape rather than passively receive.

the highly complex process of learning in which the four phases of *resonant learning* (i.e., *Engagement*, *Reflection*, *Moment of Awe*, and *Application*), can occur at any juncture (White & Wilde, 2024h).

3.6. Challenges and Considerations

Cultivating *second-order resonance* is not without challenges. As Rosa and Rüpke (2024) note, this type of resonance is not automatically guaranteed and requires continuous effort to maintain. It can grow from repeated, meaningful, *first-order resonant* experiences and fade if not nurtured. Educators can foster *second-order resonance* by staying attuned to students' experiences, regularly engaging with them to understand which activities, interests, and external factors influence their learning, and recognizing what they genuinely find enjoyable or meaningful. Therefore, educators need to be aware of how the dynamics of their classrooms and their teaching strategies either contribute to or detract from creating *resonant spaces*. *Second-order resonance* in teaching and learning is more about creating the conditions that consistently allow for meaningful, engaging, and transformative educational experiences. It involves understanding the often subtler aspects of educational environments, contributing to a sustained sense of student connection. These types of learning environments can significantly enhance immediate learning outcomes and build a lasting *impact* that students can retain beyond the classroom.

4. Teacher-Student Resonance, Alienation and *Burnout*

4.1. Resonance

One of the central aspects of resonance and alienation is the concept of the *Three Axes (Dimensions).* These include 1) *Horizontal (Social) Dimension* – the relationships one has with others and the social world (e.g., resonance with peers in a music ensemble or orchestra); 2) *Vertical (Existential) Dimension* – the connection between individuals and higher or transcendent aspects such as spiritual beliefs, natural wonders, art, or profound existential concepts (e.g., the spiritual or transcendent experience of being deeply moved by a musical composition and feeling connected to something greater than oneself); and 3) *Diagonal (Material) Dimension* – the relationship with objects or material things (e.g., a musician developing a deep relationship with their instrument, feeling as if it is an extension of oneself) (Rosa, 2019).

The classroom is a fundamental space for growth and exploration, where students acquire knowledge and develop necessary social and emotional skills through interaction and collaboration. This environment plays a crucial role in shaping a student's perspective and engagement with the world around them. Rosa explains that "*whether* music "says" something to us, *what* music speaks to us, and what space we give to this axis of resonance largely depends on our experiences in music class, perhaps in choir or violin lessons, and especially with our peers" (Ibid, 2019). It is essential to understand and create conditions that foster the four *elements of resonance* and support the *three axes*, as these are critical in cultivating environments where individuals can connect meaningfully with themselves, others, and the world.

In order to contextualize *resonance* from the perspective of a teacher and student, the two tables below illustrate the *four elements* and the *three axes (dimensions)* of resonance. **Table 2 -** provides examples of how the elements of resonance (*affection, emotion, transformation, unpredictability*) can be exhibited in both students and teachers. **Table 3 -** illustrates *resonance* across the three dimensions (*horizontal, vertical, diagonal*) for both the student and teacher.

Table 2: *Elements* of resonance - examples for teachers and students

Element	Student Example	Teacher Example
Affection	A student is moved by a classical symphony they hear in class, sparking an interest in classical music.	A teacher is inspired by students' enthusiasm during a group activity, renewing their passion for teaching.
Emotion	A student expresses joy and curiosity while listening to music or learning to play a new instrument.	A teacher feels excited when witnessing a student's progress in class or an activity.
Transformation	A student initially struggles with improvisation but gains	A teacher who was once skeptical about incorporating technology embraces

	confidence, transforming their understanding of music.	digital tools to enhance student engagement.
Unpredictability	A student unexpectedly discovers a new genre or artist during a class activity.	A teacher discovers a new teaching approach through a spontaneous classroom activity that evokes student creativity.

Table 3: *Axes* or *Dimensions* of resonance - examples for teachers and students

Dimension	Student Example	Teacher Example
Horizontal (Social)	A student establishes **relationships with peers** in an ensemble, feeling connected and supported in their musical journey.	A teacher builds a **strong relationship** with students**,** a specific class, or colleagues.
Vertical (Existential)	A student has an **awe-inducing experience** while listening to a symphony, **feeling connected to something greater**.	A teacher experiences an **emotional connection to music, history**, or a particular **composer**, feeling renewed after a school concert or class.
Diagonal (Material)	A student develops a strong **relationship with their instrument**, seeing it as something that allows them to express themselves.	A teacher becomes excited about **digital tools** such as digital audio workstations (DAWs) **or digital MIDI controllers/instruments,** finding them indispensable for teaching.

In the chapter *Schools as Resonant Spaces*, Rosa notes that "a person's relationships to the world are substantially formed in and through school" (Rosa, 2019). He explains that:

> "Particularly during puberty – a critical stage in determining the quality of our relationship to the world, when our childhood axes of resonance initially fall mute, yielding to an oft all-encompassing experience of alienation from our parents, teachers, established routines, and even our own body, before this in turn gives way to a new phase of actively adaptively transforming parts of the world – school becomes a critical, constitutive ground for the development or closure/obstruction of horizontal, diagonal, and vertical axes of resonance." (Rosa, 2019).

Rosa's view of schools as *resonant spaces* underscores the significant role of teachers in shaping a student's connection to the world. Educators attuned to the nuances of resonance can significantly influence their students' learning experiences. By recognizing the shifts in resonance that occur during critical developmental stages, teachers can tailor their approaches to support the transformational journey of their students. Incorporating the principles of *resonant learning*, as explored in the previous section of this paper, extends beyond simple knowledge transmission; it necessitates cultivating an educational environment that enables students to establish more meaningful connections with their surroundings. By doing so, educators can mitigate the risk of *alienation* and create opportunities for students to forge rich, interactive relationships with the world around them.

4.2. Alienation

To illustrate the concept of *alienation* in the teacher and student model, **Table 4 -** provides examples of how *alienation* elements can be discernible in both students and teachers. Rosa identifies *resonance* and *alienation* as opposites but does not directly distinguish the 'elements' of *alienation*. To illustrate the concept of *alienation* in the teacher-student examples, this article contextualizes *elements of alienation* as counterparts to Rosa's *elements of resonance*. **Table 5 -** illustrates *alienation* across the three dimensions (horizontal, vertical, diagonal) for both students and teachers.

Table 4: Elements of *alienation* - examples for teachers and students

Elements	Student Example	Teacher Example
Apathy / Indifference	A student feels disconnected from the music activities, showing little interest or engagement during classes.	A teacher becomes tired of teaching or exhausted by administrative pressure, losing interest in teaching or preparing new engaging class activities.
Negative Emotional Response / Impassiveness	A student expresses frustration and resistance toward playing/practicing an instrument, finding the task burdensome.	A teacher views students' lack of interest in music as a personal affront, becoming frustrated and disengaged.
Stagnation / Stasis	A student finds no joy in music and feels it does not speak to them, leading to passive participation.	A teacher feels that their efforts to inspire students are ignored, sensing a lack of connection in the classroom, and experiences a sense of **burnout**.
Mundane / Predictability	A student perceives music education as irrelevant to life, strictly adhering to monotonous, boring activities and class quizzes.	A teacher adopts one teaching approach and rigidly follows it, resisting new technology and innovative strategies in the classroom.

Table 5: *Axes* or *Dimensions* of *alienation* - examples for teachers and students.

Dimension	Student Example	Teacher Example
Horizontal (Social)	A student feels isolated from peers in a class, perceiving competition and disconnection rather than collaboration.	A teacher feels indifferent or apathetic towards students or fellow educators and does not relate to anyone.
Vertical (Existential)	A student no longer feels inspired by music and cannot find meaning or interest in any music or musical experience.	A teacher loses their passion for music, no longer feels a spiritual connection to their teaching or profession, and ultimately feels **burned out**.
Diagonal (Material)	A student views their instrument as just another task, finding no point in playing it and feeling disconnected.	A teacher struggles with digital tools and technology, feeling incompetent and viewing it as a burden.

Tables 4 and 5 aim to explain the concept of *alienation* in the teacher-student dynamic by providing general characteristics and basic examples of how *alienation* manifests and the various conditions that may precipitate it.

With the integration of ICT in education, the learning landscape becomes increasingly complex. Growing research focuses on how data-driven approaches within educational technologies designed to enhance teaching and learning contribute to student *alienation.* Pangrazio and Selwyn (2021) and Jopling (2023) argue that student alienation is increasingly exacerbated by the heightened use of technology in educational settings. Specifically, the rise in surveillance and monitoring capabilities of Educational Technology (EdTech) platforms contributes significantly to this phenomenon (Pangrazio & Selwyn, 2021). Technologies such as Student Activity Monitoring Software (SAMS) exemplify an intensification of surveillance practices, where such tools are installed on students' devices to allow real-time monitoring of their online activities (Ibid, 2021). While intended to enhance educational outcomes, this increased oversight often leaves students feeling powerless and disenchanted, negatively impacting their perception of the educational environment and their relationships within it. Jopling (2023) emphasizes the pervasiveness of monitoring, describing students as being ensnared in "an ever-intensifying network of visibility, surveillance, and normalization," a perspective that echoes Lupton and Williamson's (2017) characterization of modern educational surveillance. This aligns with observations by Selwyn et al. (2020), who critique the evolution of an 'always on' school environment facilitated by technology. This environment, termed as 'commercialized,' 'datafied' and 'platformized,' extends learning beyond traditional boundaries, often to the detriment of student well-being and autonomy (Jopling, 2023). Emerging research collectively highlights a critical and growing concern

within educational technology: the risk of *alienation* due to pervasive surveillance and data-driven practices; this is the typical ICT use in educational contexts that does not promote CIE learning. Rosa defines *alienation* as the "sense of a mute, cold, rigid, or failed relationship to the world." He directly connects it to the psychological crisis of *burnout*, discussed from the teacher's perspective in the next section.

4.3. Burnout

Amid the relentless demands of modern education, teacher burnout has emerged as a silent crisis, eroding the very foundation of 21st-century learning institutions. As educators face an onslaught of challenges, their passion and persistence are tested, threatening the quality of teaching and learning. Rosa argues that "the rapid rise in cases of burnout and depression is the result not primarily of being overburdened by work, fast-approaching deadlines, or other demands, but of the "collapse of axes of resonance that are constitutive of subjects themselves" (Rosa, 2019). Rosa references studies that "suggest that up to 10 percent of the German population exhibits symptoms of severe or chronic burnout; in certain individual fields (particularly education and nursing), the number is even as high as 30 percent." In the United Kingdom, the Education Support 2023 index showed that "teacher wellbeing" is "worsening" amongst "England's school staff" (Howard et al., 2021; Booth, 2023). Showing "more than a third (36 percent)" of teachers in the UK "reported experiencing burnout (Booth, 2023). In the United States, it is reported that "almost half of K-12 teachers feel burned out at work" (Marken & Agrawal, 2022). In 2022, Gallup, Inc. (an American multinational analytics and consultation company) conducted a poll on occupational burnout, which revealed that "K-12 teachers are identified as the most burned-out profession in the US." The Gallup survey showed that the burnout rate among K-12 teachers is alarmingly higher than in other industries (Gallop, 2022). In 2020, 36% of teachers reported feeling burned out very often or always, compared to 28% in other sectors (Ibid, 2022). By 2022, this discrepancy widened, with 44% of teachers experiencing burnout versus 30% in other industries, marking a 14% increase in the gap (Ibid, 2022). The survey also indicated that 35% of university and college teachers experienced burnout (Ibid, 2022). As Rosa explains, *burnout is* intricately linked to *social acceleration*, illustrating how the relentless pace of modern society contributes significantly to this widespread psychological crisis. He emphasizes that acceleration in society contributes significantly to dysfunction, evident in "three great crises of the present day: the environmental crisis, the crisis of democracy, and the psychological crisis (as manifested, for example, in ever-growing rates of burnout" (Rosa, 2019). Rosa makes a case that *social acceleration* is a core component of some of the world's most severe crises today, including the pervasive issue of fatigue and exhaustion (Ibid, 2019). An increasing teacher shortage is also closely linked to burnout, as excessive workloads and inadequate support drive many educators to leave the profession (Edmund et al., 2022).

4.4. Technology and Burnout

The integration of digital tools into educational practices has surged, promising innovative teaching and learning practices (Martin, 2015; Lind et al., 2020). However, this shift also brings to light a significant challenge — aligning teachers' technological skills with the escalating digital demands of modern classrooms. According to Ertmer et al. (2012), a significant barrier to effective technology use in education is the lack of resources and the existing attitudes and beliefs towards technology, compounded by varying proficiency levels among educators. This misalignment can lead to further teacher burnout – a phenomenon gaining more significance as educational environments become increasingly digital. Teachers who lack early exposure to or adequate training in emerging technologies may feel *alienated*, grappling with a sense of inadequacy and frustration. In their study, Ertmer et al. (2012) highlight the psychological barriers to technology integration in education, quoting a participant (schoolteacher from a K-12 setting) who observes that a significant impediment is *intimidation*: "There are some people who don't use technology because they're intimidated by it" (Ertmer et al., 2012). This statement underscores a common challenge educators face, pointing to the need for supportive measures that alleviate technological fears and enhance digital proficiency. This situation is exacerbated when educators perceive themselves as lagging behind their more technologically adept peers, potentially leading to a professional environment rife with stress and decreased job satisfaction. The risk of burnout intensifies without the necessary institutional support to bridge this digital divide. As Ertmer et al. (2012) point out, teachers explicitly attribute significant barriers to technology use to their attitudes and beliefs about technology and their actual skills and knowledge. To counteract this, educational strategies must focus on comprehensive professional development beyond mere technical training to foster positive attitudes toward technology. Empowering teachers with the skills

and confidence to navigate digital tools can enhance their professional capabilities, potentially mitigating feelings of *alienation* and *burnout*.

Moving beyond traditional ICT use to a CIE approach can promote a more future-centered position and supportive educational culture, where technology acts as a bridge rather than a barrier to effective teaching and learning. CIE teaching and learning can ensure that educators are fully technically and psychologically prepared in digitally enriched teaching environments by integrating technology training early in their educational programs.

5. From ICT to CIE – Creativity Transforming Music Education by Facilitating Resonant Learning Through Laptop Orchestra

5.1. Creativity

The core of CIE learning is *creativity*; the challenge of defining it, however, is evident by the extensive literature — from Graham Wallas' (1926/2018) four periods of the *creative process* in *The Art of Thought*, Alfred Schütz's discussion on "fantasy and imagination as activities of consciousness" (1951), Guilford's (1967) work linking "divergent thinking" to creativity, Hocevar's (1981) exploration of "different types of creativity measurement," Mayer's *Handbook of Creativity* (1999) to the *Encyclopedia of Creativity* (ScienceDirect, 2020), among many others, certainly the discourse on creativity has expanded significantly (Kharkhurin, 2014). Papageorgiou and Kokshagina (2022), in discussing CIE education, draw on Young's (1985) definition, which suggests that "creativity involves the skill (rather than the gift) of bringing about something new and valuable." The authors go further expanding on the meaning of creativity by referencing Amabile's (2011) "four components" of creativity, which include 1) *domain-relevant skills*, 2) *creativity-relevant processes*, 3) *intrinsic task motivation*, and 4) *social environment* in which the individual is working.

Amabile's framework outlines the key factors contributing to creativity in individuals and social settings involving complex problem-solving. The *domain-relevant skills* relate to specific knowledge, technical proficiencies, and abilities in a particular domain or field. It emphasizes that to be creative in a *field*, one must have a solid foundation in *its* underlying disciplines. This could be musical theory and performance skills for a musician, programming skills for a coder, or scientific knowledge for a researcher. The *creativity-relevant* processes involve cognitive and personality factors that enable one to think imaginatively, such as possessing or developing cognitive ability for divergent thinking (e.g., looking at problems from different perspectives), and personality factors involving traits like perseverance, tolerance for ambiguity, and risk-taking. This can be cultivated through activities such as brainstorming or experimenting with new approaches. *Intrinsic task motivation* refers to one's level of interest and passion for the task itself. Inherently motivated individuals engage in the task for the joy and challenge rather than for some external reward. This inner drive fuels persistence and creative efforts even in the face of challenges or initial failures. The *social environment* refers to the context in which an individual works. Factors such as support from family, friends, colleagues, or teachers, autonomy in the workplace, and encouragement can either enhance or stifle an individual's creativity. Amabile's model suggests that these components dynamically interact, meaning that creativity results from the *synergy* of possessing relevant skills, engaging in imaginative processes, being intrinsically motivated, and being supported by a conducive social environment. This understanding of creativity can help design better educational programs and classroom environments that effectively cultivate innovative thinking.

Boden's (2004) *The Creative Minds* is particularly relevant in a musical context; she discusses three types of creativity: 1) *combinatorial*, 2) *exploratory*, and 3) *transformational creativity*. *Combinatorial* refers to the "generation of unfamiliar (and interesting) combinations of familiar ideas" (Boden, 2004). *Exploratory* involves exploring a structured conceptual space to generate novel structures or ideas within the existing rules or conventions. In *transformational* creativity, "the variation is greater, and the stylistic dimension that is being varied is deeper," it involves "the transformation of an existing conceptual space by altering or removing fundamental rules and conventions, thus creating a new space with new possibilities" (Boden, 2004).

In an LO classroom, *combinational creativity* – which involves working with a combination of "pre-existing concepts" – is comparable to a "free-form improv" or free-style "jam session" where students juxtapose unrelated sound elements. Boden (2004) explains that these "new combinations" can produce novel and exciting results, such as collages that blend different images in new ways or analogies in poetry, visual art, and music that bring together unexpected elements. There is also the element of *unpredictability* – combinations are surprising because the elements are usually not seen as relevant to each other. However, after reflection, the connections may reveal deeper links that lead to new and meaningful insights.

Exploratory creativity involves the exploration of a "structured conceptual space" to generate "novel structures" or ideas within existing rules or conventions (Boden, 2004). It works within a predefined style or space, producing new and original works by exploring the possibilities and limits of that space. In music, this would be understood as a structured composition or improvisation within an established genre, such as Hip-Hop, Jazz, or Rock, limited to the conventions of a *style*. This type of creativity often involves deliberate experimentation to find new forms and reveal the potential and limitations of a particular space. However, it requires a higher level of acquired knowledge of the material – i.e., proficient or advanced in a subject.

In contrast, *transformational creativity* alters conceptual space's structural aspects, generating ideas that were previously 'impossible' (or unexplored or not yet conceivable) within the original space. Boden (2004) draws on Picasso's Cubism as an example of the transformation from representational to abstract art. In music, Arnold Schoenberg's shift from tonal to atonal music is a clear example of this. Transformational creativity is often met with initial resistance or incomprehension due to the radical departure from the previous conventions, requiring a shift in perception or a learning process to appreciate the new conceptual space (Boden, 2004). This form of creativity, however, is crucial in redefining artistic and scientific paradigms (Boden, 2004). Understanding these distinctions can enable educators and learners to understand the multifaceted nature of creativity and to design engaging and interactive activities that allow for the *freedom of exploration* – as discussed in the *Resonant Learning Framework* section of this paper. By recognizing the various forms of creativity, educational practices can be better aligned to equip students with the skills necessary to think critically and produce innovative and impactful ideas across different fields.

5.2. ICT → CIE: Creativity as a Form of (Re)activity

The evolution from ICT to CIE use of technology in education, viewing *creativity* as both a link and a form of *(re)activity*, reflects a more significant, transformative shift in educational paradigms. Here, *creativity* is not just about generating something new but also about *(re)activity* in the sense of responding to, adapting, and integrating new technologies and ideas within educational settings. This dual role of *creativity* involves proactive innovation and *(re)active* adaptation to changing technological landscapes and educational needs. *Creativity* as a form of *(re)activity* involves reshaping education to be more responsive and aligned with the evolving digital landscape. This shift requires integrating technology not only as a tool for teaching existing curricula but as a foundational element that transforms learning into an *active*, *interactive*, and *reactive* process.

Knoblauch (2014), in his article *Projection, Imagination, and Novelty: Towards a Theory of Creative Action Based on Schutz*, emphasizes that "imagination [...] cannot categorically be separated from action," highlighting that creativity, imagination, and novelty are intrinsically linked to the process of action. This assertion underscores the idea that creative processes are not just passive or abstract but are active and integral to the creation and execution of new ideas. This is further reinforced by Vygotsky, who viewed creativity as a *transformative* force that converts objective materials into creative outputs and alters the creator (Ding, 2023). Creativity as a *transformative* force profoundly connects to Rosa's theory of *resonance*, "*contact with the inaccessible Other* with which we enter into a responsive relationship that both permits and demands contradiction and makes possible an adaptive transformation that itself, in turn, presupposes an active experience of self-efficacy" (Rosa, 2019). Here, a compelling framework emerges for understanding how *creativity* in education can lead to significant *transformations* not only within educational environments but also within the individuals themselves (emphasized by the Resonant Learning framework). As de described by Engeström et al. (1999):

> "In fulfilling the activity, the subjects also change and develop themselves. The transforming and purposeful character of activity allows the subject to step beyond the frames of a given situation and to see it in a wider historical and societal context. It makes it possible for the subject to find means that go beyond the possibilities given."

In this light, the growing focus to CIE in education represents a profound pedagogical shift that emphasizes *creativity* and *(re)activity* – quickly adapting, questioning, and engaging with the changing educational technology landscape. The US Department of Education's Office of Educational Technology, in its report, *Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations* (2023), highlights the accelerating tension between the depth of contextual understanding and the rapid pace of technological advances. The report underscores that while the growth of technology is undeniable, there is a notable deficiency in educational research concerning the practical application of such tools in crafting a future-relevant education. The document points out the necessity to "Rethink Teacher Professional Development," questioning how new professional development systems — both for pre-service and in-service teachers — can align with technology's increasingly central role in the teaching profession (OET, 2023). This suggests a pressing need for educational frameworks that not only incorporate advanced technologies but also equip educators with the skills and knowledge to use such tools effectively. Therefore, 'ICT to CIE' signifies an evolution in music education from merely mastering technology to fostering the creativity, innovation, and entrepreneurial skills essential for students to acquire the relevant knowledge and competencies necessary to navigate a world profoundly transformed by technology, from how we live, work, and interact with each other. This article suggests that educators can navigate this transition by redesigning curriculums to integrate these components, shifting the focus from technology use to skill development through CIE, and focusing on *creativity* as a form of *(re)activity*.

5.3. Laptop Orchestras (LOs) as Maker Education (ME)

Laptop Orchestras (LOs), by their very nature, encapsulate the principles of CIE, in particularly Maker Education (ME) which has seen a rapid evolution as a powerful educational approach (Wang et al., 2022; Kim et al., 2022; Hee-Jeong Seo & Lee, 2018). While advancements in digital technology offer remarkable possibilities for individual musical creation and online collaboration, there remains a crucial element often missed in such platforms: the *essence* of collaborative musical creativity achieved through group music-making. Technology opens endless possibilities for musicians, allowing individuals to create and connect globally; however, it often distances individuals from the immersive, collective experience of making music in a group setting. Technology-mediated group ensembles, such as LOs, can facilitate "synchronized group music-making" activities; as such, "digital technologies hold the potential to cultivate resonant spaces and support student engagement" (White, 2024a). LOs further emphasize a student-centered approach that uses project practice as a medium to nurture students' innovative abilities, in line with principles of maker education (Wang et al., 2022). This aligns with the framework within which LOs operate. These ensembles allow students to engage in musical creativity and the technological creation and manipulation of their instruments. LOs embody ME by providing a space where students can directly engage with the technical and creative aspects of music production. They learn to design, modify, and use digital instruments, thus engaging in production activities that foster a "maker mindset" (Martin, 2015). This mindset is crucial for developing key competencies such as "innovative ideas and actions […] critical thinking, creativity, problem-solving and collaboration," as identified by Kang and Yoon (2017). LOs represent a dynamic model of post-digital resonant learning spaces in the arts. LOs not merely teach music; they cultivate a broad spectrum of transferable future-oriented skills and competencies through hands-on, project-based learning. This integration of music, technology, and educational philosophy offers a rich, multidimensional learning experience that prepares students to meet the challenges of future "uncertain environments" (Papageorgiou & Kokshagina, 2022). ME philosophy connects with the operational dynamics of LOs, where students are not just passive recipients of musical knowledge but active creators and manipulators of their musical outputs. According to Want et al., in *The Laptop Orchestra as Classroom*, LOs "approach to teaching is experiential. This is essential because our […] classroom setting is a distinctly unique one, and so our approach has been to collaborate and engage with the students, providing experiences of learning through discovery" (Wang et al., 2008). This active engagement is crucial for developing periods of *emergence* or *flow*, Bishop (2018) writes "the communication processes that drive ensemble coordination – particularly the processes that drive the real-time coordination of

new and spontaneous ideas." Wang et al. (2008) further describe the LO classroom setting as one that revolutionizes computer music education by shifting the focus from studio-centric courses to live performances. Unlike traditional approaches concentrating on studio construction techniques and playback, LOs integrate live performance directly into the curriculum. This method utilizes "meta-instruments" that enable students to explore sound individually and collaboratively without being overwhelmed by a conventional sound system. Interacting with the computer becomes a tool for creative expression, with immediate *sonic energy* feedback that stimulate further inquiry and experimentation. Students not only learn technical skills but also gain valuable experience in group dynamics and musicality. Wang et al. (2008) explain that the overarching goal of LOs and similar initiatives is to create an integrated, *interdisciplinary* educational environment where ideas from various fields merge seamlessly to achieve a common creative goal.

6. Conclusion

"…education succeeds as a complex process of *adaptive transformation of (the) world.*"
– Hartmut Rosa (2019)

This paper introduces the *Resonant Learning* (RL) framework expanding Hartmut Rosa's sociological theory of resonance and Wallas' the creative process. The concept of *resonant learning* emphasizes the importance of *creativity* in digitally-mediated post-digital educational landscapes. It outlines the need to for Creativity, Innovation, Entrepreneurship (CIE) use of ICT, emphasizing how CIE and Maker Education (ME) methodologies not only enhance the learning experience but also prepare students for the challenges of a rapidly evolving education. This paper contextualized *creativity* as *(re)activity* and aims to encourage an educational environment responsive to technological innovation and the shifting economic and societal landscapes. By exploring the integration of laptop orchestras (LOs) in education, the paper identified critical avenues for enhancing teacher training. Technology mediated learning spaces, such as LOs, were discussed as essential for adapting teaching methods and curricula to the rapid technological changes and diverse intercultural educational needs. The evolving demands of teacher development underscore the necessity for educational programs that continuously adapt to the latest technological changes, ensuring educators can effectively incorporate relevant tools in future education. This paper does not aim to be conclusive and intends to refine the RL framework introduced here. Future studies will explore the need for a framework specifically accounting for *post-digital* learning spaces and the implications of the *digital axes* of resonance within Hartmut Rosa's sociological theory. These concepts could offer researchers a toolkit for applying a nuanced framework to examine both human-computer interaction (HCI) and the evolving human-AI interaction (HAII) in the learning process. A post-digital RL framework can aid in shaping research questions that investigate how digital technologies enhance and complicate educational experiences, spaces, and methodologies, as well as questions concerning human existence and 'co-presence' in an increasingly digitally-mediated world. By continually exploring these intersections, educators and researchers can leverage technology more critically and effectively.

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