Encounters between music, education and technology

Editors:
Adolf Murillo, Jesús Tejada, Pablo Marín, Mª Elena Riaño,
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artslab educación artística contemporánea

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INDEX

INTRODUCTION

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The intersection of music, education, and technology forms a fertile ground for research and experimentation that has significantly transformed our conceptions of music and arts education. In this book, Encounters between Music, Education, and Technology, innovative approaches and emerging methodologies that integrate technology into the field of music education are explored, promoting creative, inclusive, and contextually adapted pedagogical practices. The various chapters bring together a multitude of perspectives on experimental music creation, the use of digital tools, and the exploration of new learning paradigms, positioned at the crossroads of technological advancements and pedagogical needs.

Each contribution opens a dialogue on how musical experiences are amplified and transformed through interactive spaces, devices, and methodologies. From recognizing space as a fundamental element in sound perception to analyzing the possibilities of artificial intelligence in music composition and education, this book gathers reflections and results from pioneering projects in various contexts. The included research not only examines the impact of these technological encounters on educational practice but also proposes a reconfiguration of music pedagogy as a creative space where bodily cognition, student autonomy, and interdisciplinarity converge.

Throughout its chapters, the reader is invited to consider how technology can reshape music education towards a paradigm that challenges disciplinary separation and embraces collaborative creation and sensory exploration. This work not only documents concrete advances in the use of technologies in music learning but also invites a deeper reflection on the role of creativity, experimentation in education, and performativity, providing an inspiring vision of the possibilities that the technological future offers to the field of music pedagogy.

In Chapter 1, Josep Manuel Berenguer analyzes the relevance of physical space in the musical experience, an aspect often underestimated by both musicians and listeners. Through a public experiment, Berenguer explores how the acoustic characteristics of a space influence the perception and reception of sound and music, questioning traditional boundaries of musical performance.

In Chapter 2, Esteban Peris Aviñó investigates the use of embodied cognition in music learning through sensors. By integrating the body as a medium of cognition, this chapter shows how technology enables the capture and communication of bodily gestures to the computer, highlighting the possibilities of active methodologies and embodied cognition in music education.

Can artistic and creative projects transform teaching practices? Pedro Vicente Caselles Mulet explores how artistic projects in music, dance, and technology can revolutionize teaching. Based on case studies from various European institutions, the chapter evaluates the impact of these projects on learning and the educational community, emphasizing their transformative potential in pedagogy.

In this chapter, Jesús Jara López presents the Sonotrónica program, an innovative course for young students that uses live coding as a musical learning tool. This approach challenges traditional methods by integrating computer programming as a means to develop musical skills, questioning traditional language and methodology in music education.

In this chapter, Adolf Murillo and Jesús Tejada describe the development of digital tools based on sound creation to foster creativity in music education. These tools, created in collaboration with experts and university teachers, aim to transform educational practices towards more creative approaches, placing students in an experimental environment where they explore technology innovatively.

In the next chapter, Nóra Varga and Petri Kärkkäinen investigate the use of electroacoustic music in an artistic workshop for teenagers at a summer camp in Helsinki. Through four perspectives (technology, meaning of sounds, social interaction, and community autonomy), this chapter examines the challenges and impact of integrating electroacoustics and art into youth education.

For this chapter, Jesús Tejada and Adolf Murillo describe ArtsLab, a laboratory at the University of Valencia dedicated to developing educational software aimed at solving pedagogical issues in music teaching. This chapter presents tools like Tactus, Cantus, and Plectrus, designed to mediate between thought and action, facilitating the educational experience in music.

In this chapter, José Luis Miralles Bono examines the role of artificial intelligence in music education, focusing on its capacity to compose and teach classical music. Using Chopin's nocturnes as a case study, the chapter compares AI-generated works with traditional ones and reflects on the possibilities of these technologies in music teaching, as well as the ethical challenges involved in their use.

In the penultimate chapter, Professor Pamela Burnard invites readers to reconsider traditional conceptions of creativity in education, advocating for a posthuman approach that integrates bodies, materials, and environments in a relational and sustained pedagogical practice. The work advances new methodologies that emphasize the importance of interaction with the environment as a means for creative learning in music education.

Finally, the closing chapter by Professor Clint Randles and Bo Garrard presents a collaborative autoethnographic research that narrates the journey of an undergraduate student interested in the relationship between intentional timbre choices and resulting musical products. In a context where technology has blurred the boundaries between specialized musical roles, this study explores how music production and consumption have evolved, profoundly affecting music teaching in higher education.

This set of chapters offers a rich and multidimensional view of how interactions between technology, music, and pedagogy can redefine music and arts education. The reflections presented here emphasize that technology, beyond being a mere tool, is a catalyst for new methodologies in which the body, space, and environment acquire an active role in learning. From spatial acoustics exploration to the use of sensors and live coding, each contribution reveals the potential of interactive experiences and sensory exploration to connect students with music and art in a meaningful and transformative way. Thus, the importance of rethinking the role of technology is underscored—not as an end in itself but as a means that enriches creativity, autonomy, and innovation in education.

As a whole, Encounters between Music, Education, and Technology presents itself as an invaluable resource for teachers, researchers, and creators interested in building an educational model adapted to the demands and challenges of the 21st century. This book, with its integrative and interdisciplinary approach, raises questions and opens pathways towards a more inclusive pedagogy sensitive to technological and cultural changes, fostering an education where creativity and knowledge are not only transmitted but co-constructed in an environment of constant experimentation and discovery.

1

”Acústicas maquínicas”: space, its aural imprint, and experimental music

"ACÚSTICAS MAQUÍNICAS": SPACE, ITS AURAL IMPRINT, AND EXPERIMENTAL MUSIC

Josep Manuel Berenguer
Màster en Art Sonor · Universitat de Barcelona
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ABSTRACT: We often fail to be fully aware of the musical significance of the space where musical events take place. Although in different ways, this is an aspect that affects both listeners and musicians alike. We expend great effort mastering the internal behavior of sounds: pitch, dynamics, temporal relations, expressive nuances, meaning, phrasing, etc. These are matters that engage and concern us throughout our long years of study and in the preparation of pieces that will fill our programs. This chapter outlines a public experiment conducted with the aim of conveying to listeners the notion that the characteristics of spaces play a pivotal role in the experience and reception of sound and music.

KEYWORDS: Musical space, aural architecture, experimental music, telepresence, sound art.

BACKGROUND FRAMEWORK

If the positioning of performers within the concert space has been, at least since the 16th century, a well-understood and discussed topic, the myriad of tonalities that concert spaces can bring to the musical experience and musicality often fall outside the range of concerns that, throughout history, we as musicians have chosen to address. It seems akin to certain technical issues traditionally viewed as external to the musical act, which are usually delegated to third parties whose artistic competence we often don't know.

A space is defined by the boundaries arising from its geometry. This allows for its definition in terms of variables that condition the existence of objects within it. These objects, in turn, themselves define the limits of the given space, restricting the possibilities for other objects in their vicinity (Berenguer, 2009). Hence, in the daily musical experience of humans, the relevance of space is not the apparent emptiness that the transparency of air allows us to perceive, but the boundaries of the container: the architectural space.

It cannot be said that music or sound art reside in the movement of sounds through the mass of air that connects their sources to the listener's ear. Nor can we find it in the auditory sensations from which it emerges as a mental space. Music, like sound art, is a subset of the realm of experiences, such that it is not directly related to the passage of time or to the points in the mechanical space from which the sounds that evoke it may originate. As we need to refer to two types of space of distinct nature in this text, from this point on, when we write *space*, we will be referring to some architectural space, a subset of the space of classical mechanics, therefore. The mental realm of musical and auditory experiences will be referred to here as *musical space*. For stylistic simplicity, when we write *music*, we will be referring to any artistic expression conveyed by sound, including *sound art*.

Music is not a feature of sounds or their spatio-temporal arrangement. However, two sound signals, even if identical at their sources, if generated in spaces with different reflective properties and reverberations, sound different to those who experience them. Even the same sound signal is not perceived the same in different places. Given our auditory and musical expectations, not all spaces are suitable for hosting any type of music. Moreover, the transformation of the sound spectrum due to reflections at the boundaries of spaces and their reverberation time might have greatly influenced the emergence of certain musical styles.

RESONANCE AND SPATIAL INFLUENCE IN MUSIC

The sounding boards of musical instruments reshape the sounds produced by their vibrating mechanism. This transformation does not end with the sound's emission in the instrument's vicinity. Any space acts as a resonance box when sound is generated within it, as if it were an extension of the musical instruments. A paradigmatic case is that of church organs, whose musical experience is inseparable from the transformations resulting from reflections inherent to the architecture of each temple. Mechanical spaces also have the ability to modify the internal nature of the sound signals reaching the ear, which, indeed, allows for the discrimination of the physical properties of the spaces we inhabit. Analogous to how we perceive them when illuminated, we hear architectural elements due to the way they reflect sounds. Thus, we can perceive the environment in the dark, and that's why, since its appearance, the auditory apparatus has provided an advantage concerning the survival possibilities of species that possess it. The arrangement of objects and surfaces allowed by their geometry fosters the emergence of aural architecture, meaning the sonic identity of a particular space.

All of this grounds musical discourses of spatialization in terms of allegories and metaphors related to the parallel existence of that mental space of music we mentioned; the only one, indeed, that we intimately know. Because the ultimate knowledge of space in classical mechanics, just like other aspects of reality, is shown to us humans, in Bernard d'Espagnat's terms, as if between it and us, outside of time and space, there was a veil. Indeed, the musical poetics of space can be interpreted in these terms: as space colors sound, it influences the musical experience to the extent that performances of a certain score can result in very different musical objects depending on the space in which they resonate or from where they are heard. Just for this reason alone, which is significant, the acoustically relevant details of spaces should be considered a variable with musical significance. Thus, it's striking that space, so determinant of the musical experience, is only considered an anecdote in most musical study programs, traditionally devoted to mastering pitches, spectra, dynamics, timings, and interpretative details. Incidentally, the same can be said for publications. Traditionally, then, we've tended to think that these aspects sufficiently explain musical phenomena. But looking back, it's evident that the *organa* from Notre Dame's school in Paris might not have been composed as we know them today if the reverberations of their large, hard-walled spaces hadn't sustained the sounds for so long after their sources ceased. Similarly, it's hard not to think about the reflections on the bark of thick Cameroonian jungle trees when hearing the polyphonies of the semi-nomadic Gbaka community, characterized by rapid changes between normal voice and falsetto, as in the Tyrolean Yodel, and the *hoquetus*[1] technique.

Reverberation is a memory that sustains sounds beyond the stimulation period of their source. This elongation distorts them in duration and spectrum; a detail that, three centuries after Leonin and Perotin and with the consolidation of a taste for Flemish polyphony in Venice—much more agile than the old Parisian *organum*—first led Adrian Willaert, the maestro di cappella of St. Mark's Cathedral, and a bit later Andrea and Giovani Gabrielli, organists of that monumental basilica with high domes prone to the loss of voices in its recesses, to create the first *polychoral music*. The use of the *cori spezzati* strengthened and balanced the reception of the voices' sound, naturally evolving to place different instrumental and vocal groups in significant areas of the basilica. The correction or masking of what was considered an acoustic flaw led to the development of the *stile concertato*, so characteristic of European Baroque. Another serendipity.

RESONANCE IN VARYING SPACES

In spaces with long reverberation, the presence of active emissions from different sound sources creates sound clouds that mask the origin points of the sounds. If this magic emerges from human voices, the effect intensifies to astonishment when the sounds are more varied, such as those in a soundscape, and are played through loudspeakers. Together, the waterfall, the field full of grasshoppers, the pine forest teeming with cicadas, the nocturnal insects and the jungle birds, the wind, the industrial machines, and the traffic sounds, perform an acoustic miracle that we are fortunate to appreciate thanks to the multifocal installations characteristic of electroacoustic music. Examples include the nearly spherical concert hall whose construction was led by Stockhausen in Osaka in 1970 (Ansorge et al., 2022), or the multiple loudspeaker devices that played the works of Iannis Xenakis in his *polytopes* (Boole-Stott, 1913), or the domes of Léo Kupper (1984), the *Halaphone* (Schonberg, 1974) by Hans Peter Haller, for

1] Translated to English, *hiccup*. It's a melody alternately shared between different voices.

which Luigi Nono composed many of his electronic works, or the acoustic space that Renzo Piano designed for *Prometeo, Tragedia dell'Ascolto* (Richard, Jeschke, Schabert, Hirsch), originally conceived by Nono for the basilica of San Marco, although the premiere ultimately took place in the church of San Lorenzo. Also, the more recent sophisticated and complex sound reproduction systems, which surround the audience with differentiated sound-emitting speakers, are capable of reviving sensations from different acoustic spaces than the room in which they play. Examples are the *Gmebaphone* from GMEB[2], designed by Christian Clozier (2001), the *Acousmonium* (Barthélemy et al., 2008) of the INA-GRM[3], which, conceived by François Bayle, came a little later, or the more modern ambisonics systems (Arteaga, 2023) and wave field synthesis (Ziemer, 2020).

When I was a resident at GMEB, later called IMEB[4], composers usually spent weeks immersed in the solitude of a studio equipped with the most sophisticated technical resources and almost perfectly soundproofed. These were generally meticulous productions, conceived in the introspective solitude of the studio and developed during intense work sessions under these ideal conditions. However, when presenting the pieces on diffusion devices integrated by dozens of speakers in the diverse spaces the gothic city of Bourges offers, the surprises for the creators could be overwhelming. Some felt disappointed because many of the sounds weren't heard as they expected. Sometimes, they weren't even audible. Others, equally surprised, delightedly discovered aspects of their work that they hadn't been aware of up to that point. Both groups learned that the concert space is not the same as the studio. Showing this reality was part of my job there. Transferring electroacoustic music from the studio to the concert space can be traumatic and, at the same time, a rewarding experience. Therefore, in the studio, it's essential to be clear about the intended use of the music being made. It's not the same to produce music to be listened to with headphones or a few speakers at home as it is to be heard on one of those devices, typically installed in a large space. In general, for a single piece, it is advisable to create versions tailored to each of the contexts in which it is intended to be heard.

The need to think of music for its publication on social networks, which patently and through electronic treatments, such as convolution reverb, tends to generate sensations of individual space in consumers, has

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2] GMEB : Groupe de Musique Expérimentale de Bourges.

3] INA-GRM : Institut National de l'Audiovisuel - Groupe de Recherches Musicales.

4] IMEB : Institut International de Musique Électroacoustique de Bourges.

increased the tendency to forget the importance of external spaces, places where musical experience can occur collectively without the mediation of communication technologies.

"ACÚSTICAS MAQUÍNICAS": THE EXPERIMENT

The *Espacios resonantes*[5] festival (2022) is dedicated to raising awareness of the sonic and musical influence of architectural spaces. It is directed by Chilean architects Sofía Balbotín and Mathias Klenner (2020), whose artistic research focuses on spaces with extremely long reverberations. As a community, the festival offers a critical view of built environments, especially the ruins left behind by progress. Because of its ability to construct narratives alternative to the dominant ones, *Espacios resonantes* proposes the aesthetic practice of listening and sound creation as transformative tools of reality. Its mission consists of introducing the practice of exploring and transforming built environments through sound experimentation, with the purpose of observing, analyzing, and highlighting the interaction between architecture and listening in spaces derived from abandoned industrial architectures, with long reverberations, where, in the directors' terms, "sound stops in time, and space emerges." It's a poetic way to highlight the idea of reverberation as memory.

In 2022, their activities took place in Quinta Bella, Recoleta, near Santiago de Chile, with the support of the Museum of Contemporary Art of the University of Chile. The focus of that year's festival edition was the creation of a collective and participatory space from which, thanks to various sonic activities, both generation and listening, the aural architecture of two abandoned urban structures emerged: a 25-meter-tall water tower and a buried reservoir of 1, 100 m^3.

In mid-2022, the festival directors invited the Master in Sound Art program from the University of Barcelona to participate in the programming for November of that same year in the *Estanque de agua*, the name given to the buried reservoir. This structure is cylindrical, covering an area of 220 m^2, with a diameter of 16.8 meters and a height of 5 meters. Inside, there is a structure of nine pillars supporting the covering slab, spaced 3.9

5] Espacios resonantes: Resonant Spaces

Image 1: General view of Quinta Bella with the water tower and the circular esplanade, beneath which lies a water reservoir named Estanque de agua.
Photo by: Felipe Mardones.

meters apart in a 3x3 matrix arrangement. In an article not yet published and written by Constanza Ipinza, Sofía Balbontín and Mathias Klenner, it is revealed that the reverberation time of the *Estanque de agua* is 24 s.[6] Above the water reservoir, there is an esplanade where other festival activities took place. The old underground water storage tank was adapted to host octophonic concerts. The initial proposal for the Master in Sound Art was the classical exhibition of a joint work for fixed support, which the festival itself named "Acústicas Maquínicas".[7] This would be executed by Lina Bautista, Anna Gatz, Ginebra Raventós, and the author of this article, all of whom are graduates or professors of the master's program. It was based on the recordings from *Els sons de la indústria - Arxiu del patrimoni acústic i sonor de la industrialització a Catalunya*[8] carried out by the *Patrimoni Acústic* collective (2023), comprised of Ginebra Raventós, Emilio Marx, and Mathias Klenner.

6] RT60 the time in which the level of a signal drops 60dB below the initial value.

7] *Acústicas Maquínicas:* Machinic Acoustics.

8] The sounds of the industry - Archive of the acoustic and sound heritage of industrialization in Catalonia.

Image 2: Interior of the Water Reservoir. Photo by: Felipe Mardones.

However, given the fascinating characteristics of the space proposed to us, in constant dialogue with the festival directors, we jointly conceived an educational activity for both concert attendees and the performers themselves. This activity was intended to be live, aiming to share in a purely experiential manner the constellation of ideas about auditory space expressed earlier. Since activities involving the use of multiple speakers for soundscaping various spaces are commonplace in the master's program, as are telepresence activities, which became essential after the pandemic, we decided to undertake an experiment. To our knowledge, this experiment may not have been previously conducted by other researchers, and its details follow.

In essence, we wanted concert attendees in a given space to experience sound reflections from a different space than the hall where the concert was taking place. Of course, we could have added reverb to the sounds using convolution reverb with the impulse response of the desired space. This is a well-known and highly effective technique, but this time, with the explicit intention of departing from the virtual realm of simulation and thereby reinforcing the sense of reality within the domain of classical mechanics, we preferred to hear the real-time response of a distant room. Given the unique reverberation conditions and sound coloring of the underground reservoir in Recoleta, we thought it would be highly instructive to teleport its acoustics to the Sala Ricson of Hangar.org[9] in Barcelona. This

9] Hangar.org is a Barcelona prominent entity dedicated to artistic production, with which the Master in Sound Art and the Orquestra del Caos collaborate.

is located 11, 000 kilometers away and has a completely different resonant nature. The Sala Ricson is essentially a nearly square box of 230 m2 (14.75 m. x 15.25 m.), 8 meters high, with brick walls covered in a slightly absorbent material. Its reverberation time does not exceed 2 seconds.

Image 3: Panoramic view of the Sala Ricson at Hangar.org. Photo by: Diana Medina Prieto.

In fact, the concept should not seem unfamiliar: the old plate reverberations, which were of large dimensions, could be shared among various recording studios located in the same building. The procedure involved sending the signal to be reverberated to one of these devices, which could be arbitrarily distant, and then routing it back from the plate to the studio that had requested the service, where the original signal was typically mixed with the reverberated one. Of course, given the age of the procedure, the process was carried out with analog technology. In our case, however, we had the technological tools to send high-quality sound to any location worldwide, play it there, and capture the result with microphones to return it to the place of origin. In the *Sala Ricson* of Hangar.org, in Barcelona, Anna Gatz, Diana Medina Prieto, Ginebra Raventós, and I prepared a setup to improvise with the materials from *Els sons de la indústria - Arxiu del patrimoni acústic i sonor de la industrialització a Catalunya,* which we would have used in the fixed media piece.

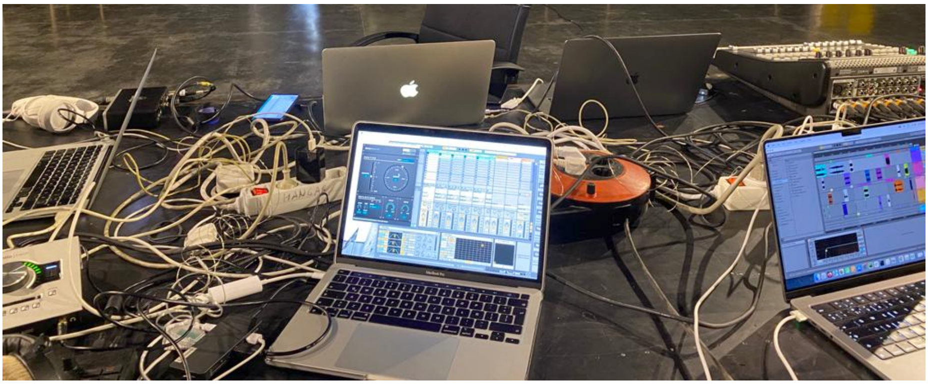

Image 4: Setup for improvisation in the Sala Ricson. Photo by: Diana Medina Prieto.

The setup consisted of 4 computers connected via a Behringer X32 mixer to a fifth computer that mixed the signal in stereo and sent it as a server of Netty McNetFace (Puckette, 2020), through 420 UDP ports to the Internet. This signal was received in Recoleta by a Netty McNetFace client implemented on another computer, played in the eight-speaker configuration set up in the *Estanque de agua* - and heard by the attending audience there - captured by a pair of high-quality microphones and sent back from the Recoleta computer to the same computer that had sent it from Barcelona. This computer played it, unmixed, in the eight-speaker configuration of the *Sala Ricson* of Hangar.org via the same mixer that had captured the signal from our four computers, also connected to the eight speakers. I should clarify that the eight-speaker configuration wasn't genuine since the signal arrived in stereo. In reality, we had four stereo systems, each on one of the walls of the room.

Diana Medina Prieto was responsible for generating the images displayed in the *Sala Ricson* of Hangar.org during the concert.

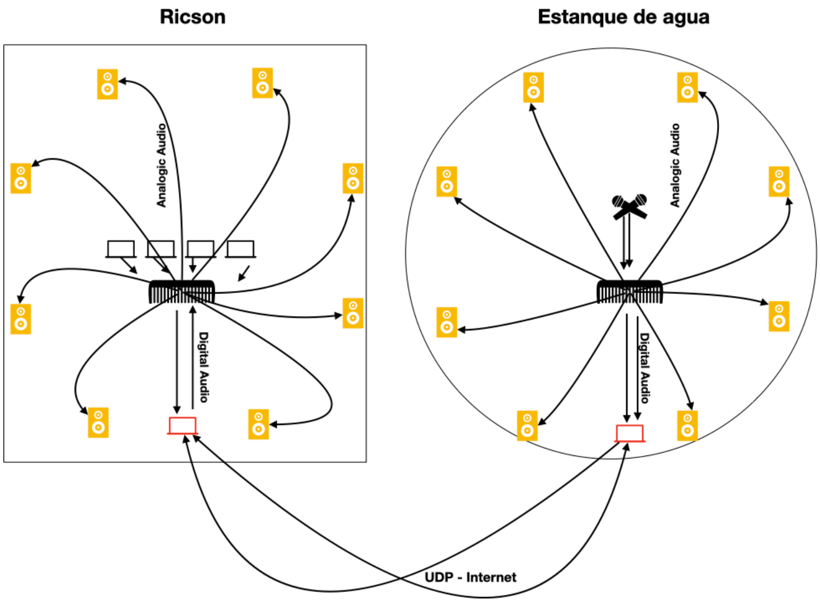

Image 5: Signal diagram of "Acústicas maquínicas".

CONCLUSION

Before starting the improvisation session, attendees, who were briefed from the outset about the experiment they were partaking in, could hear the usual response of the *Sala Ricson* to the production of sounds without the mediation of any electronic device. In fact, the event was promoted as such on social media, ensuring attendees had a prior understanding of what they were about to hear. It was a thrilling experience for all. The industrial sounds submerged in that hyper-reverberant space took on ghostly textures of varied qualities, making them very challenging to identify. The truth is that the sounds shared in both spaces, *Sala Ricson* and the *Estanque de agua*, were entirely novel; and this happened due to the filtering at the *Estanque de agua*, which besides dramatically altering their spectrum, kept a range of frequencies circulating from one place to another, based on the composition of the input spectrums. Indeed, it seemed as though the sound sources were moving even though we sent them in a completely static manner. This is a sensation I've often experienced in multifocal concerts. However, on that occasion, the difference in movement between the treble parts of the sounds and the bass parts was particularly pronounced. A more thorough investigation would be needed to decipher this phenomenon. For now, I dare to put forth a conjecture that I have yet to verify. Clearly, the sounds themselves don't move. As new sounds emerge from a point, let's say a speaker, they reflect off the confines of the space. If the reflections are potent, this process persists for what could be several seconds. The spectrums produced in each reflection zone shift progressively, but not uniformly since not all surfaces reflect frequencies equally or simultaneously. As such, the older spectrum parts disappear at different times and places in the space, potentially resulting in a perceived movement of the sounds. That movement, transferred to four stereo systems, might have been amplified due to reflections within the *Sala Ricson* itself, which, of course, is not inert.

At the concert's conclusion, attendees' impressions were discussed and shared among them in the very room from which the signal had been sent and its transformation received. It was evident to all participants that the improvisation signal coming back to Barcelona from the *Estanque de agua* in Recoleta would never have been possible in the *Sala Ricson* of Hangar.org. Consequently, the response of the distant space played a decisive role in generating the content we collectively experienced.

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2

Embodied cognition through sensors

EMBODIED COGNITION THROUGH SENSORS

Esteban Peris Aviñó
Jaume I University of Castellón de La Plana and "Maestro Ponce" Professional Conservatory of Chella (Valencia).

ABSTRACT: The basis of active methodologies is internalisation through experience, through personal experiences. Some of these methodologies focus on the use of the body as a cognitive element, Embodied Cognition. The advance of technology offers us enormous possibilities to work with the body as an element of cognition, one of them being to communicate body gestures to the computer through sensors.

KEYWORDS: Embodied Cognition, Arduino, Max/Msp, Music Education, Sensors

INTRODUCTION

The most widely accepted and widely used methodologies for teaching music from the most elementary levels are those developed in the 20th century by Carl Orff, Zoltan Kodály, Émile Jaques Dalcroze and Edgard Willems. These methodologies coincide in considering that the approach to music at the most elementary levels must be experiential, so that students must be guided to "make" music and assimilate musical concepts, such as rhythm or intonation, through practice before beginning with the theoretical foundations.

Likewise, methodologies such as that of Carl Orff (Orff, 2004) propose the use of the body itself as an instrument (body percussion) and others, such as that of Émile Jaques Dalcroze, promote synchrony between the perceived sound stimulus and the body's own movement. (Jacques-Dalcroze, 2017).

Taking into account the wide acceptance and use of the pedagogical concepts proposed by these methodologies, the application of *Embodied Cognition*, coming from cognitive psychology, together with the use of technological tools such as Arduino[1] and Max/Msp[2] can completely transform the way of approaching work in the classroom, redefining the musical educational experience.

FOUNDATIONS OF EMBODIED COGNITION

The key principle of embodied cognition is the idea that mind and body are not separate entities, but interrelated components of an integral sys-

1] Arduino is an open source platform that combines hardware and easy-to-use software to build electronic projects. It consists of a programmable circuit board (usually called a microcontroller) and a software or integrated development environment (IDE) that is installed on the computer to write and load code onto the physical board.

2] Max/MSP is a graphical object programming environment for application in sound and multimedia systems, created by Miller Puckette at I.R.C.A.M. (Paris). Currently the maintenance, development and updating of the program runs on the software is owned by the American company Cycling 74', which is in charge of developing updates and maintaining the program.

tem that connects our physical and sensory experiences. (Varela et al., 1991). Rather than seeing thinking as a purely cerebral activity, embodied cognition argues that our physical, gestural and sensory experiences are central to understanding how we process information.

One of the central concepts presented by embodied cognition is that of sensorimotor simulation. This concept suggests that, when perceiving a sound stimulus, we mentally simulate the physical actions associated with the production of the perceived sound. (Gallese & Lakoff, 2005).

Embodied cognition also addresses the question of how the body influences cognition through conceptual metaphor (Lakoff & Johnson, 1999). Conceptual metaphors are mechanisms through which we understand abstract concepts in terms of physical and sensory experiences. For example, the conceptual metaphor "music is a journey" implies that, like a physical journey, music has a beginning, a development and a destination. By using bodily metaphors in music teaching, educators can tap into the natural connection between the body and the mind, facilitating the understanding and retention of musical concepts.

These theoretical foundations promulgated by embodied cognition find direct application in music teaching, since, as we have seen, it is accepted that music theory should not be approached in a purely abstract way, but experientially, and for this it is necessary that physical action and sensory experience become vehicles for the application of these concepts in music teaching, as they suggest that physical action can greatly facilitate the understanding and internalization of abstract musical concepts. When students physically interact with music, they are engaging in a form of learning that goes beyond mere memorization, not only intellectually understanding concepts, but also feeling and experiencing them on a bodily level.

Embodied cognition also stresses the importance of the interaction between perception and action. The idea is that the way we perceive the world and how we interact with it are intrinsically linked. In the musical context, this means that how we listen to music is connected to how we interpret and produce it. Understanding music as a dynamic interaction between perception and action facilitates the development of a deeper understanding of how one's actions influence musical creation and performance.

ARDUINO

The integration of embodied cognition in music education is significantly enhanced by the use of technological tools. In this context, tools such as Arduino and Max/MSP are very versatile tools that offer a platform for the creation of interactive and personalized educational experiences.

The Arduino platform can be considered highly recommended for use in the educational field, as the software of this platform is free and open source and the hardware itself (microcontroller board) can be acquired at a very low price. Its versatility lies in its ability to work with a large number of devices without the need for extensive programming knowledge. One of the most interesting ways of using Arduino in education is the use of sensors and actuators, allowing students to explore the direct relationship between their body movements and the production of sound. Motion sensors such as accelerometers, gyroscopes and flexometers, which can be purchased very easily and cheaply, can be used to capture specific gestures and movements and automatically translate them into musical events. This tangible and direct interaction promotes a deeper understanding of the connection between body and music.

A practical example of the application of Arduino in music education could be the creation of an Aerophone. Students can use air pressure sensors connected to the Arduino to modulate musical parameters such as volume and timbre by simply varying the force with which they are blowing into the sensors. This experience provides a direct connection between the physical action and the sonic result, enriching musical understanding.

Work such as that of Wanderley and Battier (2000) in "Trends in Gestural Control of Music" explores how gestural interfaces, especially those based on technologies such as Arduino, have evolved to enable more intuitive and experiential musical expression. (M. Wanderley & Battier, 2000).

MAX/MSP

This software is a powerful tool for sound creation, widely used by musicians and sound artists all over the world for audio processing in live performances and concerts, as well as for sound art installations.

The full name of the program is Max/MSP-Jitter and refers to the three environments in which the program can work:

- Max: Creation and programming of MIDI controllers.
- MSP: Sound generation, synthesis and processing.
- Jitter: Graphical environment for video processing

Through the use of Max we can generate almost any kind of sound, which can allow us to approach music away from the tonal-modal environment of Western classical music, proposing to the students the listening and creation of other types of sound organisations and soundscapes.

Max/MSP thus presents a very broad and highly capable working environment that, among other things, facilitates the creation of interactive software for music and multimedia arts.

ARDUINO AND MAX/MSP

The joint action of Arduino and Max/MSP opens up a whole world of possibilities for experimentation with and through sound. This joint action consists of the calibration and programming of the sensors on the Arduino platform, which sends the reading of the parameters obtained to the Max/Msp program so that it can use these parameters to generate sound events.

Interactive instrument design with Arduino and Max/MSP provides a learning opportunity where students can explore the connection between body gesture and sound production.

Using motion sensors, a practical exercise could be to assign gestures to specific sound events. For example, upward movement of a hand could increase the intensity of the sound, while downward movement could decrease it. Another example of an interactive instrument could be the creation of an "interactive string instrument". Bending sensors (flexometers) connected to the Arduino could translate arm bending into variations in pitch and volume, allowing students to experiment with the relationship between physical gesture and musical expression.

This type of experimentation not only explores the relationship between gesture and music, but also encourages creativity in musical composition.

Wanderley and Depalle's (2004) work in "Gestural control of sound synthesis" has demonstrated how gestural interaction, especially when using Max/MSP, can play a crucial role in collaborative music creation, providing students with a platform to experiment with embodied cognition in composition.(M. M. Wanderley & Depalle, 2004)..

Another practical example could be the construction of a "light and sound instrument", using optical sensors that capture the intensity of light. The optical sensors programmed in Arduino could be assigned to a controller in Max that varies the volume, so that the greater or lesser intensity of the light translates into greater or lesser sound intensity. In this way a physical perception translates directly into a related sound perception, the higher the light intensity, the higher the sound intensity and vice versa.

This way of working not only introduces students to the basic concepts of embodied cognition, but also allows them to apply theoretical concepts in the construction and experimentation with their own instruments.

Research such as that of Jensenius (2007) in "Action-Sound: Developing Methods and Tools to Study Music-Related Body Movement" has highlighted the usefulness of platforms such as Max/MSP for studying and applying embodied cognition in specific musical contexts. (Jensenius, 2007).

Other academic works underline the effectiveness of these technologies in improving music education. Works such as that of Kopiez (2011) in "Making Music and Making Sense Through Music: Expressive Performance and Communication" (Kopiez, 2011). (Kopiez, 2011)highlight how the application of embodied cognition, facilitated by technologies such as Arduino and Max/MSP, can significantly enrich the music learning experience by providing an avenue for personalized exploration and artistic expression.

COLLABORATIVE PROJECTS

The combination of Arduino and Max/MSP in music education not only provides practical tools, but also encourages collaboration and creative experimentation. Group projects where students design and execute musical performances using these technologies not only develop technical skills, but also promote interaction and the exchange of ideas between participants.

Research by Jensenius and Wanderley (2010) in "Developing Tools for Studying Musical Gestures within the Max/MSP Environment" highlights how interactive instrument design can provide an effective platform for studying and applying embodied cognition in the context of music production. (Jensenius et al., 2005)..

Effective and efficient design of interactive instruments involves the integration of various sensors and controllers. Motion sensors, such as accelerometers and gyroscopes, allow for capturing specific gestures, while actuators, such as vibrating motors or LED lights, can enhance the sensory feedback. This approach not only provides a rich, multi-sensory musical experience, but also strengthens the connection between the performer's body and the music produced.

Research such as that of Hunt and Wanderley (2002) in "Mapping Performer Parameters to Synthesis Engines" highlights the versatility of Max/MSP to design gestural interfaces that improve the connection between the performer's physical action and the sound production. (Hunt & Wanderley, 2002).

The design of such interactive instruments and devices not only has technical implications, but also has a significant pedagogical impact. By allowing students to actively participate in the creation of their instruments, the appropriation of musical knowledge is fostered in a deeper way. Embodied cognition is enhanced when students not only understand musical concepts theoretically, but also experience them directly through action and interaction with their own creations.

Working with Arduino and Max/MSP also favors the acquisition of STEAM (Science, Technology, Engineering, Arts and Mathematics) skills by combining technical and creative aspects in the educational process.

ETHICAL CHALLENGES AND CONSIDERATIONS

While the integration of embodied cognition in music and technology education offers us a wide and fascinating range of possibilities, it also raises fundamental ethical challenges and considerations that need to be addressed.

TECHNICAL CHALLENGES

One of the fundamental technical challenges lies in the complexity of designing and maintaining interactive systems, especially when integrating devices such as Arduino and Max/MSP into educational environments. The need for specialized technical expertise can be overwhelming for educators and students alike. In addition, the rapid evolution of technology can create constant challenges in keeping systems up to date and ensuring compatibility with new software and hardware releases.

Wanderley and Orio's (2001) research in "Evaluation of Input Devices for Musical Expression: Borrowing Tools from HCI" highlights the importance of critically evaluating technologies used in music education to address technical challenges and ensure long-term effectiveness. (Orio et al., 2001).

ETHICAL CONSIDERATIONS IN DATA COLLECTION

The integration of interactive technologies often involves the collection of biometric and behavioral data from students. This process raises ethical considerations about privacy and data security. Ensuring the protection of students' personal information and obtaining informed consent prior to data collection are crucial aspects that need to be carefully addressed.

EQUITY IN TECHNOLOGICAL ACCESS

Disparity in access to technology can create challenges in implementing approaches based on embodied cognition. Not all students may have equal access to technological devices, which can contribute to gaps in learning. Addressing equity in technological access becomes crucial to ensure that the benefits of such methodologies are available to all students, regardless of their resources.

Warschauer and Matuchniak's (2010) work in "New Technology and Digital Worlds: Analyzing Evidence of Equity in Access, Use, and Outcomes" highlights the importance of critically examining how technology affects equity in education. (Warschauer & Matuchniak, 2010).

ETHICAL CONSIDERATIONS IN CURRICULUM DESIGN

The integration of embodied cognition raises ethical questions about how to design curricula that maximize educational benefits without exposing students to unnecessary risks. The inclusion of interactive technologies should be guided by ethical principles that prioritize the safety, inclusivity and well-being of students. In addition, educators should consider how to address the diverse needs and learning styles of students to ensure that it does not exclude any group for any reason, whether social or economic.

Guzdial and Tew's (2006) research in "Imagineering inauthentic legitimate peripheral participation: an instructional design approach for motivating computing education" highlights the importance of ethical and authentic curriculum design in education. (Guzdial & Tew, 2006).

When incorporating interactive technologies, it is also necessary to address cultural and social considerations to ensure that educational approaches are culturally sensitive and respectful. Educational practices must be adapted to reflect the diversity of learners' cultural experiences and perspectives. Ignoring these considerations could perpetuate cultural biases and limit the accessibility of this methodological application to specific groups.

Gay and Kirkland's (2003) work in "Preparing for Culturally Responsive Teaching" highlights the importance of cultural sensitivity in teaching in order to ethically address diversity in the classroom. (Gay, 2002).

The challenges and ethical considerations in the integration of embodied cognition and technology in music education require careful attention to ensure equity, privacy and cultural sensitivity. Addressing these ethical issues is essential to creating enriching educational experiences that respect diversity and promote meaningful and ethical learning.

CONCLUSIONS.

The integration of embodied cognition in music education through interactive technologies represents a paradigm shift that can redefine the relationship between mind, body and music education and thus transform the way we conceive and practice music education.

Embodied cognition proposes a new approach to, or rediscovery of, conventional notions of the relationship between mind and body, proposing a holistic perspective where cognition is intertwined with physical action. In the context of music teaching, this involves recognizing that the understanding of music theory is not a process isolated from physical experience. Rather, sensorimotor simulation and the application of conceptual metaphors allow students not only to abstractly understand music, but also to experience it through movement, gesture and physical action.

Looking to the future, embodied cognition can play a crucial role in the evolution of music education. The combination of interactive technologies, the exploration of new pedagogical approaches, without neglecting attention to the ethical challenges raised, can make embodied cognition a transformative force in music education. Collaboration between educators, researchers and technology practitioners will be key to developing innovative and sustainable educational practices.

Beyond music, the implications of embodied cognition extend to education in general. The idea that the body and mind are inseparably intertwined has the potential to redefine pedagogy across disciplines. The application of embodied cognition can enrich teaching and learning by offering more immersive and participatory experiences. This holistic perspective can inspire new approaches to education in science, mathematics, humanities and other disciplines.

In conclusion, the integration of embodied cognition in music education with interactive technologies represents a bold step towards a more dynamic educational paradigm. This approach invites educators, researchers and practitioners to reflect on current practices and to continuously explore new ways to enrich music education. Embodied cognition not only redefines music teaching, but also raises fundamental questions about how we conceive of education as a whole. By integrating mind and body, theory and practice, it shows a path towards a more vibrant, participatory and meaningful educational future.

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3

Can artistic and creative projects transform teaching practices?

CAN ARTISTIC AND CREATIVE PROJECTS TRANSFORM TEACHING PRACTICES?

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ABSTRACT: This article delves into the potential pedagogical transformation brought about by artistic and creative projects in educational contexts. It explores a range of projects, spanning music, dance, and technology, aiming to uncover how creative initiatives can reshape teaching practices. Drawing from the first-hand involvement of Pere Vicalet, it examines projects across diverse institutions in Portugal, France, and Spain. Through the analysis of surveys, interviews with educators, students, and organizers, as well as reflections, we evaluate the profound influence on learning and education within the educational community. Discussions and conclusions provide a comprehensive overview of the impact of creative-educational projects over the past decade and how it affected to the teaching practices.

KEYWORDS: Creative Projects, Artistic Endeavors, Teaching Transformation.

INTRODUCTION

In recent years, there has been a growing interest in understanding the transformative potential of creative projects in educational contexts. This surge of interest has been particularly evident in the literature, as highlighted by several influential works in the field. Some teachers and researchers shed light on various facets of the relationship between creative projects and education, providing valuable insights into the pedagogical impact of such endeavors.

On the last 10 years there has been somehow a revolution in the way of our youth society understand and move on their day-to-day practice. In this case, related to the music teaching and the advances of technology there has been some worries about how we can adapt to them. For example, we find some reflections that explore the adaptation of music education to the challenges posed by the COVID-19 pandemic, emphasizing the pivotal role of real-time technology in reshaping teaching methods (Calderón-Garrido, 2021). Meanwhile, there are other recent investigations that underscores the educational power of real-time technology, particularly in the realm of video games, for fostering creativity and interactive learning (Squire, 2010).

In addition, some researchers introduce the concept of TPACK, offering a framework for designing effective real-time learning environments. TPACK represents the intersection of technological knowledge, pedagogical knowledge, and content knowledge, and it serves as a foundational concept for effective technology integration in teaching (Hunter, 2015). It provides practical guidance on designing learning experiences that align technology, pedagogy, and content to optimize student engagement and achievement. Hunter emphasizes the importance of considering the unique needs of individual learners and tailoring technology integration accordingly. In same aspect, we can apply to the focus on synchronous online teaching and learning, highlighting its significance in contemporary education (Finkelstein, 2009).

We find this preoccupation also in other authors that advocate for the importance of creativity in education and recognize the potential of technology to nurture it (Aronica, 2016) or on the calls for a reimagining of university education with an active, technology-infused approach (Davidson, 2017).

Certainly, these projects from the past decade have collectively emphasized the significance of creative endeavors and technology in reshaping pedagogical practices, engaging students, and enriching educational outcomes. Drawing inspiration from the insights and perspectives presented in these projects, this article seeks to contribute to the ongoing discourse surrounding the impact of creative projects on music and programming technology education.

As mentioned before about TPACK, where it is the intersection between different areas, and also for understanding the evolution of presented projects in this paper on last decade, it is necessary to go deeper into the relation between all those areas and to clarify different grades of interrelation between all aspects involved on each one of those projects:

- Multidisciplinarity: it occurs when models and theories from different disciplines converge, often within the confines of a collaborative team. Each member contributes their expertise towards a shared objective, after which they return to their respective fields. This represents the initial level of collaboration, although, at times, individuals may remain unaware of their colleagues' work in other domains (Gasper, 2001).

- Interdisciplinarity: it is characterized by creative endeavors undertaken through dialogue, coordination, collaboration, and the transfer of tools and methodologies from multiple disciplines. It implies a shared space where different fields intersect, resulting in a holistic integration of knowledge from various participating areas (Hardorn and others, 2008).

- Transdisciplinarity: it occurs after extensive interdisciplinary work has paved the way for the emergence of an entirely new knowledge domain. This phenomenon transpires when all conceivable extensions from diverse disciplines coalesce into a novel discipline. It involves transcending the boundaries of one or more pre-existing disciplines to arrive at a joint solution to a creative question, thus necessitating the formation of a new discipline. (Cieseielski and others, 2016).

- Eclecticism: it encompasses the usage of citations from multiple sources or creative techniques, ranging from general stylistic references to direct textual quotations. It includes collage, assimilation, and the utilization of established practices from various artistic movements, including neoclassicism and influences from folklore or other cultures. However, it's essential to note that eclecticism has been used pejoratively to describe works where the author, due to a lack of originality, freely borrows from existing creative models. (Griffiths, 1981).

- Intertextuality: it is when discourse becomes a citation of other discourses, and the understanding of a given discourse relies on reference to other texts. This term encompasses various relationships between two texts and typically involves one text's presence in relation to another, whether through plagiarism, citation, or allusion. (G., 1989).
- Polystylism: it emerges when multiple styles or techniques from literature, art, film, or especially music are employed. It is a characteristic of postmodernism and entails systematic techniques, such as citation, pseudo-citation, allusion, the use of popular melodies, instrumentation from other composers, and more. (Schnittke, 2002).

While eclecticism is often seen as a passive approach that brings together materials from various sources, polystylism represents an active evolution of this idea. In polystylism, the creator takes an active role in organizing and seamlessly blending various elements of the creative process to intentionally craft a new style. This purposeful approach has the potential to give rise to an entirely new discipline, aligning closely with the concept of transdisciplinarity, which is a central objective in most of the projects discussed in this article.

By examining a range of projects and methodologies, drawing from empirical data and experiential insights, this article aims to provide a comprehensive exploration of how artistic and creative projects, spanning concepts from multidisciplinarity to intertextuality, hold the capacity to revolutionize teaching practices and reshape the educational landscape from previous projects to the last projects. In doing so, it contributes to the broader discourse surrounding innovative and effective educational approaches in the 21st century.

1. DEVELOPING PROJECTS

At the beginning, there were some projects collaborating with other artists or teachers, like in 2008, alongside Carlos D. Perales, we made some sound installations in open areas. Primary goal was to showcase the wonders of electroacoustics rather than formal education, these projects were instrumental in raising awareness about how to make these new concepts accessible to a broader audience just "gaming". Step by step, this urgency to disseminate knowledge to a wider audience was more evident and was also a way of doing projects for how people could be more involved.

Some other projects from this period are the collaboration between acoustics and technology the 2013 ENSEMS festival with M4chhina Ensemble with piece 'Local Landscapes. This marked a groundbreaking moment as it was the first time lights, video, music, and sensors were combined, expanding the boundaries of artistic expression. Additionally, there were ventures into sound-action performances, such as the collaboration with dancer Rita Góbi (Budapest) at the *Festival Punto de Encuentro* in 2014. While these specific projects may not have been primarily educational, recognizing their history provides valuable context for the evolution of educational initiatives.

At the beginning all those participating projects were more like multidisciplinary projects where each one has its own work and all were working for a common project, but from beginning to the end, as it were alone. Time to time, it developed also to projects where all people was in contact with other people, generating kind of translation of all data involved on each area, going more deeper into the concepts of interdisciplinarity or transdisciplinarity.

1.1 *ENSEMS*

After participation in the multidisciplinary *Local Landscapes* piece with the *M4cchina Ensemble* in 2013, as said before, we have been involved in several other collaborative projects where the integration of various art forms and meticulous attention to multiple aspects beyond the typical day-to-day performance have been of paramount importance. These experiences have played a crucial role in achieving a harmonious integration of the artworks presented arriving to integrate sound discourse inside other nonmusical aspects related to performance.

1.1.1 *ENSEMS 2018 - FRESCO*

The Youth Wind Band from FSMCV participated in the 40th edition of the ENSEMS Festival with Luca Francesconi's work *Fresco.* This event, themed *Recorreguts sonors a l'espai* (Sonic Journeys in Space), features five moving bands for a sonic interaction at the Centro del Carmen in Valencia. To grasp the concept of this work, it takes us back to Venice in the late 16th century when composers like Giovanni Croce and Gabrielli orchestrated dialogues between two choirs in the St. Mark's Basilica, using different spaces.

More recently, the concept of sound spatialization in motion brings us to composers like Edgar Varèse with *Poème électronique* and Iannis Xenakis with *Concret PH*. These pieces were conceived to be performed in the Philips Pavilion, designed by Le Corbusier with Xenakis' assistance. The spatialization of sound in motion gained prominence, especially in the latter half of the 20th century, partly due to technological advancements developed for film music. (Roads, 2015)

The instrumental concept of the work *Fresco* could find its predecessors in Charles Ives *Three Places in New England* and K. Stockhausen's *Gruppen*. In these compositions, different rhythmic formations, accompanied by unusual placements of the musicians, create new sonorities intentionally, as is the case with *Fresco.*

Participating as an artistic coordinator and conductor, the goal here was to practice and teach to youth amateur musicians about what was the main musical aspect, moreover than the unique playing from each musician. We needed each musician to complete own task of listening the global texture result to integrate to it. We provide them the feeling of what we were expecting to hear at the beginning, however, we realized that this can only be practiced in live, and not from the theoretical aspect. Also, we had to prevent any possible error in organization on space moving for each marching band and ensemble. We needed some previous coordination meetings of work with all 6 conductors, and finally we decided to be connected live with an in-ear walkie-talkie.

1.1.2 *XENSEMS 2019 – SONAR I DANSAR LA CIUTAT*

Continuing in this idea of the space, this XENSEMS project explored a wide-ranging relationship with sound, while critically addressing biases and hierarchies presented in classical and contemporary music traditions, delving into the concept of acoustic territory, focusing on the interplay between space and sound. It prompts reflection on the relevance of the traditional canon, which, despite its historical context, still influences how we engage with different forms of music that require alternative approaches and modes of thinking (Cabaretta, 2014).

It was a challenge to develop conventional spatial distinctions and aiming to establish new spaces through sound. The project encompassed workshops developed by several professors on voice, movement, percussion, experimental improvisation, and electronics, culminating in a collaborative sound exhibition. Selene Sánchez and Roser Domingo collaborated on the electronic workshops alongside Vicent Gómez, Joan Soriano conducted the percussion workshops, Josep Lluis Galiana led the experimental improvisation workshops, and finally, Cristina Gómez conducted the movement and body expression workshops. This project was all co-liderated by Marina Hervás, Vicent Gómez, Adolf Murillo and Cristina Cubells.

These workshops explored how sound can reshape our understanding of spaces and incorporate various creative techniques, including the integration of technology, modulation of roles and the body's involvement in sound creation. Ultimately, the project strives to broaden our perception of spatial boundaries and foster more inclusive sound environments.

Once again, it had leaded space for the practicum for all students. Despite the initial division of work among different workshops and spaces more like multidiscipliniraty, this division proved necessary to subsequently achieve a joint presentation. Later, as we had meetings for coordinating the event, we started to be influenced by all disciplines like interdisciplinarity. Furthermore, this influenced the composition of the work's score from the outset, which consisted of a graphic score encompassing not only the sonic aspect but also the spatial aspect, simplifying the pedagogical management of the workshop.

1.2 *MULTICOLABORATIVE PROJECTS*

1.2.1 *MUSIC AND TECH EDUCATION THROUGH OPERA - LA MARE DELS PEIXOS (ENRIC VALOR)*

As it is known, the production of an opera, particularly when it takes on a pedagogical dimension and incorporates technology, we could say that stands as one of the most transdisciplinary and intertextuality endeavors in the realm of art. In this context, the work of a local author like Enric Valor holds immense potential to profoundly influence education across various dimensions. These educational facets encompass not only the production itself but also the active involvement of students in various on-stage roles, being an oportunity to infuse music and technology seamlessly into the curriculum while celebrating the richness of local literature and culture.

La mare dels peixos the Enric Valor's opera, blends traditional storytelling with cutting-edge technology, culminating in an immersive educational experience. What sets this apart is that students aren't mere spectators, they actively engage in crafting music and soundscapes using mobile devices through the SoundCool system, a platform they've explored during their own lessons. This hands-on approach to music composition not only nurtures their creativity but also deepens their grasp of fundamental musical concepts (Murillo & Sanchez, 2017).

From the musical conducting aspect, we could observe how the pedagogics and trough the course of rehearsals, we were changing and being more efficient about how to explain students could contribute to the collaborative. We experienced which language should be given directly for the harmonious synergy among diverse teams and institutions involved in the production. The integration of technology assumed a crucial educational dimension, serving as a catalyst to motivate and coordinate students while rendering their learning experience highly immersive and indelibly memorable. In essence, this educational journey transcends the confines of traditional classrooms, equipping students with skills and knowledge that resonate in today's interconnected world, often facilitated by the ubiquity of mobile phones.

1.2.2 *50TH ANNIVERSARY FSMCV - COMPOSITION OF EL GUERRER DE LA VALLTORTA*

The 50th Anniversary FSMCV event in Castelló marked a significant milestone for Music Schools and Music Societies, highlighting the role of technology in education, and with the objective of winning several Guinnes World Records emphasizing the intergenerational nature of Music Societies, and taking the largest lesson with more students. The event celebrated the accomplishments of over 6, 000 students from Music Schools associated with 211 Music Societies in Castelló, València, and Alacant.

As in work *Remors de multituds* from *Sonar i dansar la Ciutat* of XENSEMS, the composition of the performance of *El guerrer de la Valltorta,* was conditioned on first instance because the event that will be played by more than 6000 students, from different disciplines. And also, what set up the beginning for the elaboration of this performance apart was the innovative incorporation of technology, specifically 120 students playing its own smartphones and tablets through system Soundcool.

Here the challenge about teaching were in somehow, same as before. We only could sum up all together same day before performance. So every part and team, had to be developed its own work very clear, from technology through music, from lights to sonorization. Everything had to be planned, pre-assumed the errors, and having each solution in live for each possible technical problem that could arrive.

1.3 *CSMV PROJECTS*

At Sonology Department in CSMV, there are several subjects that are related directly to the process of making projects, and other ones that require to plan a project development, to achieve all theoretical aspects of the subject. This is the case of the subject Sound Engineering for events.

1.3.1 *A REAL PARTICIPATION – MOSTRA SONORA WITH ANTARA ENSEMBLE*

With this subject of Sound engineering for events, we quickly realized the need to move beyond the confines of our theoretical classroom and embrace practical problem-solving through real-world cases. To achieve this, we collaborated with the Antara Ensemble, an ensemble associated with CSMV, known for performing contemporary pieces and also with electroacoustic elements, and also with *Mostra Sonora*'s Festival from Sueca (ValÈncia). We engaged students in playing several works, transforming the classroom into a real-life case study and confronting the challenges of live concert preparation.

Throughout these experiences, we encountered various obstacles that demanded creative solutions. For instance, we delved into complex compositions like Stockhausen's *Microphonie* and Gérard Grisey's *Jour Contre Jour*. These works required in-depth analysis and re-interpretation of the score and also from the devices that have to be played.

We had to modernize outdated electronic devices, essentially resurrecting making a kind of archaeological technology. This involved the development of software solutions to replace obsolete hardware, which, at times, led us to deviate from our initial plans. In the process, students learned valuable lessons in teamwork, task delegation, problem-solving, and adaptability.

One of the most significant benefits of undertaking such projects was the role transformation it brought about. We all worked together towards a common goal, which not only made the projects successful but also taught us the importance of collaboration and adaptability when working towards a shared objective. These experiences transcended traditional classroom learning, providing students with valuable insights and practical skills that will serve them well in their future careers.

2.3.2 *A PROJECT DEVELOPMENT IN CSMV*

This subchapter is about the subject ubicated on fourth year of Sonology's Degree at Superior Conservatory from Valencia at the last course. After two years of full theory activity, students go deep to the build of their own project. In first way on a collective one, and finally, they develop their own project. The unique rule they have is that they must develop a project that has to combine aspects from at least 2 subjects from Sonology speciality.

- For this last course on 22-23 for example, we developed some projects like the project: *Sound Mirror,* from Lucia Garcia Valiente, which was an interactive sound performance that uses facial recognition to detect user emotions and generate real-time images and videos. It aims to provoke reflection on the pervasive use of facial recognition technology and its implications in a data-driven era. The innovative aspect was utilizing a starter point of IA for facial recognition technology to create an immersive musical experience, blurring the lines between music, emotion, and visual art.
- Other project was *Jackie*, from Raul Pina, and it was a multi-platform 2D platformer video game developed in *Godot Engine* and connected to MaxMsp via OSC through an intranet server. The challenge here was to learn on the beginning how to code via Godot, and then, how to combining video game design, music, and technology to create an interactive gaming experience with potential applications in music composition and performance. On the industry there is a team developing all these issues. For the project, it was only Raul, and we started both, teacher and student, from nothing knowledge about this software.
- Third project *Acousmatic VR,* from Jose A. Cebrián was an interactive audiovisual installation in virtual reality where users can interact with their body gestures to produce electronic music and witness the transformation of their surroundings with the music. The innovative

aspect was the merging virtual reality, music production, and gestural interaction to create a unique audiovisual experience from the nothing. In this case, also student and teacher started quite close from null point of how to code with Unity, and also how to take data from it to call to Max MSP.

- Other pedagogy project created on this year was the *SSTED* (Solid State Tape Emulator Delay), from Genís Ibáñez. This was a project that had a sound effect that simulates the behavior of a tape delay but with analog signal processing controlled digitally via a computer application. The challenge here was about how to combine analog sound processing with digital control, offering musicians a unique tool for sound manipulation.

- Finally, there was a collective work called *Operistic!* were students designed a data protocol for controlling all possible parameters in an opera performance. This is to control the lights, the audio for the audience and also for the players, the subtitles, the possibility of firing video or recording, only from one unique worker. We knew how to do everything alone, but we wanted to mix all those areas, making a new product, in this case, going deep into the concept of transdisciplinarity.

Each of these projects represents an innovative approach to music and technology, showcasing how technology can be harnessed to create new musical experiences and expressions, whether through interactive sound performances, video games, virtual reality, or sound effects devices.

The challenge inherent in these projects, when viewed from a conventional perspective, lies in their pioneering nature, pushing the boundaries of what is commonly understood by society. In fact, in each of these endeavors, we found ourselves in uncharted territory, often necessitating the creation of entirely new scripts or code libraries to realize our project objectives. This isn't a traditional classroom scenario where a teacher delivers pre-packaged lessons, and students merely absorb information to pass an exam. Instead, it's an environment where the professor confronts the limitations of their own knowledge, while students are not only encouraged but required to excel in specific domains, sometimes surpassing the instructor's expertise.

As it is asserted in *Experience and Education*, traditional educational methods often fall short in accommodating such dynamic and exploratory learning environments (Dewey, 1938). In this dynamic, the professor assumes a role more akin to that of a project collaborator, shedding light on both the vulnerabilities and strengths of the projects, akin to a coach. They provide guidance, not just from their experience but also by remaining prepared for multiple possible project trajectories. Unlike a standard classroom, each session becomes a real-time, evolving process with numerous potential solutions. The teacher's responsibility extends beyond simply proposing these solutions, they must meticulously analyze each one and actively participate in the decision-making process to ensure the project's well-being and progress.

This transformative approach to education challenges the traditional teacher-student dynamic and underscores the importance of adaptability, collaboration, and expertise within a constantly evolving educational landscape. It reflects the idea that innovation often emerges at the intersection of diverse perspectives and collaborative effort, driving progress in ways previously unexplored.

2.3.3 *IMCC PROJECT 2020-2023*

The IMCC (International Masterclass in Creative Composition) leaded by *Gustave Eiffel University* from Paris was project aimed to address the evolving landscape of Western musical creation since the 2000s, emphasizing the need for financial and institutional transnational arrangements and skills in linguistic and multicultural areas. It focused on fostering learning mobility and employability by confronting pedagogical methods for teaching international musical composition and disseminating concepts and tools related to music composition and sound creation. The project conducted masterclasses in *Gustave Eiffel University of Paris* and also on *Universidade Nova* de Lisboa, *Superior Conservatory of Music from Valencia*, and the *École Nationale Supérieure d'Art de Bourges.* Each masterclass had its specific objectives and activities, and emphasized the development of digital art portfolios, recordings, and radio broadcasts as pedagogical tools, moreover than the creation of a work in only one week from teams of students mixed from all four institutions. The project had a significant impact on students, teachers, and partner organizations, fostering creativity, digital skills, multicultural competences, and international collaboration.

The methodology used included thorough planning, regular online meetings, pedagogical discussions, and collaboration with technical teams. The digital art portfolios served as tools for students to showcase their competences and skills, while recordings of masterclasses and concerts facilitated feedback and peer sharing. The project aimed to enhance students' employability in the music industry by improving their composition, technical, and organizational skills. It also encouraged autonomy in concert organization and networking with professionals. The project's interdisciplinary and intercultural nature contributed to a dynamic and motivating learning environment.

The IMCC (International Masterclass in Creative Composition) project had a profound impact on students, teachers-researchers, and partner organizations in the way that we realized that our day-to-day lesson is in somehow, out of route of the real work on a company which could be in somehow more stressing. Students participating in the project experienced accelerated learning, improved emotional control, and a greater appreciation for diverse artistic perspectives, which are more difficult to teach in the normal teaching.

They also noted the project's resemblance to an Erasmus-like experience, providing condensed yet impactful international exposure, not only in the professional way, also in the personal one. Also, we get from the surveys that the hands-on practical exercises and objectives received had more high ratings from students, emphasizing the effectiveness of active learning approaches, than the objectives that were organized only for achieving them from a theorical point of view or from a lecture or conference. The impact was higher on learning by doing.

Teachers-researchers benefitted from collaboration and knowledge sharing across partner institutions, enriching their courses and pedagogical approaches. We gained valuable experience in conceiving and organizing large-scale international artistic and pedagogical projects. The importance of reverse pedagogy and inductive approaches in artistic creation was recognized, and relationships with colleagues were strengthened from our multiverse approach to the teaching concept from creativity to the technique aspects.

Partner organizations, including Université Gustave Eiffel, gained international project experience and established new collaborations, both locally and regionally. IMCC opened doors to future cooperation possibilities, such as international master and PhD programs in music composition or sound arts, and facilitated the acquisition and development of basic skills and key competences among students, encompassing musical composition, digital skills, multicultural competences, linguistic skills, and artistic sensibility.

The project showcased the compatibility of partner institutions, fostering ideas for structured cooperation initiatives, and for now, students have made their own projects moreover from institutions. Overall, the IMCC project played a vital role in promoting open education and innovative practices in the digital era, emphasizing creativity, collaboration, and the effective utilization of digital resources in music composition education.

3. DISCUSSIONS AND PRECONCLUSIONS

From the first projects presented in this article, we can view that first ones were from two or three different disciplines, and last ones, were realized with so many people and large institutions. From the first projects we can observe that, as soon as they started, we figure out that we needed a very huge amount of prevision from all areas involved. We had to concentrate for sure on the pedagogics, but also on the coordinating pedagogics between everyone. We had to focus on all possible errors that could make a fatal error for performance, for the 30 minutes time of rehearsing and we had to solve them before start to think where to start on the project on its practical way.

From the las projects, on IMCC we experienced from the surveys asked to all agents participating on project, that we moved from beginning to the end of project into a new needs and different procedures of teaching all International Masterclass in Creation and Composition. This project introduced several noteworthy pedagogic improvements, leading to transformative outcomes for students:

- Practical Learning Empowerment: Adopting a practical approach placed students at the center of knowledge application, empowers students to actively develop and apply skills and concepts was better due that students rated practical exercises higher than conventional lectures and conferences. So we concluded that lectures and conferences laid the foundation, while practical work facilitated higher-level learning.
- Guidance for Informed Decision-Making: Providing students with guidance on how to approach challenges and anticipate issues before project realization boosted their confidence in problem-solving and helped them clarify their project directions.
- Enhanced Student-Teacher Relationship: The elimination of rigid class roles created a collaborative environment, fostering a shared

purpose among teachers and students. The collective effort and shared responsibility contributed to a positive learning experience.

- Varied Learning Approaches: Approaching student guidelines from different perspectives, ranging from deductive to inductive, allowed students to progress through various levels of learning, starting with copying and imitating or following instructions; then continuing by being provided with resources for experimenting and venturing into the unknown; and ultimately showcasing creativity from their own leaded project.
- Diversity and Collaboration: Working with students from diverse backgrounds and disciplines encouraged the exchange of unique knowledge and broadened perspectives. Collaborative environments promoted discussions, idea articulation, and active listening. These needs giving them time, to explain themselves any issue, without professors, improving the education on long terms.
- Stress-Induced Growth: Introducing elements of stress disrupted traditional learning routines and prompted students to explore their targets, emotions, and knowledge. We figure out we had never trained them for real life stressfully situations. Stepping out of their comfort zones fostered personal growth and a deeper understanding of their creative capabilities, moreover than in the day-to-day lessons. And we started to prepare them emotionally for how to manage stress in a building of a performance inside creative process.

After all those projects presented on IMCC, we must say that artistic and creative projects have emerged in our institution as powerful tools for reimagining and rejuvenating teaching practices in the modern educational landscape. These projects, which often incorporate technology and innovative pedagogical approaches, offer a dynamic means of engaging students and fostering deeper learning experiences, forcing all to go to the limitations and broke them. Once limits are broken, all agents should be prepared for it for solving.

One key aspect of their transformative potential lies in their ability to tap into students' intrinsic motivation. When students are given the opportunity to express themselves creatively, whether through music, visual arts, theater, or other forms of artistic expression, they become active participants in their own learning journey. This shift from passive absorption of information to active creation and exploration not only enhances their sense of agency but also ignites their curiosity and passion for learning.

Also, we have experienced that some special students being only prepared for achieving concepts in the role of teacher explains and students hears and study, they have at the beginning several problems for starting to do from themselves. In these special cases, we have experienced that if teacher provides a grammar for creative thinking and a palette of creative questions for the student to start to think by himself once it gets blocked, it encourages the act of teaching and prevents of future abandonment. In somehow, from our experiences it's just they don't know how, and need an extra plus of guidance.

In somehow, we faced that some students just are waiting for the moment that you are confident with them, trust in them, and propose them a real target that they don't know already they can achieve, but as they trust in you, then they are able to do it. In these cases, motivation is from themselves guided from teacher, and learning process is from all: from student and also from teacher.

Solved this issue, artistic and creative projects also encourage interdisciplinary thinking also to these students. They blur the lines between traditional subject areas, allowing students to draw connections between seemingly unrelated topics. This interdisciplinary approach mirrors the complexity of real-world challenges and encourages critical thinking and problem-solving skills, which are invaluable in today's rapidly changing world.

Furthermore, in an overall look from all these projects, we must say that we used technology as a tool for creativity and collaboration, and for meeting their own work as an artist. Whether students are composing music using digital software, creating multimedia art installations, or collaborating with peers from different locations through virtual platforms, technology helps and enriches the creative process. It opens up new avenues for experimentation, sharing, and feedback, enhancing students' digital literacy and 21st-century skills.

Students learnt to work together, to share ideas, and to give and receive constructive criticism collectively bringing their visions to life. These collaborative experiences fostered social and emotional skills, such as communication, empathy, and resilience, which are important as competences for academic and professional settings. And we experienced that those students participating on projects, also improved the teaching process from other students. It is to say that they improved the rest of courses sharing experiences and having meetings with those classmates.

Focusing more on the CSMV projects, we can view that in these projects, the challenge lies in their pioneering nature, pushing the boundaries of societal norms and expectations. They often require the creation of entirely new scripts or code libraries, unlike traditional classrooms where teachers deliver standardized lessons and students passively absorb information. Instead, these projects foster dynamic and exploratory learning environments. Professors assume roles more akin to project collaborators, guiding students and actively participating in decision-making but leaving some decisions to student for their learning process. This transformative approach challenges traditional education, emphasizing adaptability, collaboration, and expertise. It highlights that innovation often arises from diverse perspectives and collaborative efforts, driving progress in previously unexplored ways.

So, after all this reflections, we constated improvements on teaching transformations on following features:

- Intrinsic Motivation: Artistic and creative projects tap into students' intrinsic motivation, making them active participants in their learning journey and fueling their curiosity and passion for learning.
- Interdisciplinary Thinking: These projects encourage interdisciplinary thinking, fostering connections between diverse subjects and promoting critical thinking and problem-solving skills.
- Technology Integration: Artistic projects made often incorporated technology, enhancing creativity and collaboration while also improving students' digital literacy and 21st-century skills.
- Collaboration and Teamwork: Collaborative experiences in creative projects teach students essential social and emotional skills, including communication, empathy, and resilience.
- Tangible Outcomes: Creative projects yield tangible, shareable outcomes that provide a sense of accomplishment, self-assessment tools, and opportunities for reflection and improvement.
- Role Transformation: Engaging in these projects shifts the roles of both educators and students, emphasizing collaboration, adaptability, and shared objectives.
- Practical Learning: Practical exercises empower students by placing them at the center of knowledge application, boosting their confidence and practical problem-solving skills.
- Guidance for Decision-Making: Providing guidance on approaching challenges and anticipating issues helps students clarify their project directions and enhances their problem-solving abilities.

- Enhanced Student-Teacher Relationship: Collaborative learning environments foster a shared purpose among teachers and students, creating a positive and constructive learning experience.
- Diversity and Collaboration: Working with students from diverse backgrounds encourages the exchange of unique knowledge and broadens perspectives, promoting discussions and idea articulation.
- Stress-Induced Growth: Introducing elements of stress disrupts traditional routines, fostering personal growth and a deeper understanding of creative capabilities.
- TPACK and STEAM Models: Effective integration of technology into teaching, guided by models like TPACK (Technological Pedagogical Content Knowledge) and STEAM (Science, Technology, Engineering, Arts, and Mathematics), promotes holistic learning experiences. In those, we constated that technology's role revolutionizes music education, offering new ways to enhance the learning experience, stimulate musical creativity, and facilitate interdisciplinary learning, and also ensuring the inclusivity enhancing innovative methodologies.
- Ongoing Evaluation and Advancement: Educators should continuously evaluate and advance their digital pedagogy to meet the evolving needs of the digital age.

CONCLUSIONS

In conclusion, artistic and creative projects hold the potential to transform teaching practices by engaging students on a deeper level, promoting interdisciplinary thinking, embracing technology, fostering collaboration and teamwork, and providing tangible outcomes for assessment and reflection. Educators who harness the power of these projects can create dynamic and enriching learning experiences that prepare students for the challenges and opportunities of the 21st century.

With the IMCC project, pedagogic improvements emphasized the transformative impact of practical learning, clear guidance, collaborative environments, diverse perspectives, and stress-induced growth. These enhancements empowered students to take ownership of their education, enhanced their communication and problem-solving skills, and deepened their understanding of music composition in the digital era.

Therefore, in conclusion, after a comprehensive examination of the discussed projects from a pedagogical perspective, we can assert that the development of creative projects aimed at achieving artistic objectives has the potential to reshape classroom and teaching practices. These projects place a spotlight on the specific requirements of the project, thereby revealing both areas where students may be lacking and their strengths. This approach can be employed to ensure a comprehensive education that addresses all essential aspects, ultimately yielding more favorable outcomes in real-life scenarios.

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4

Sonotrónica: Live coding in the context of a music school

SONOTRÓNICA: LIVE CODING IN THE CONTEXT OF A MUSIC SCHOOL

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ABSTRACT: *Sonótronica* is an after school course available for students from 8 years old at the public music and dance school "María Dolores Pradera" located in Madrid, Spain. Instead of the traditional music technology class used to complement a general course in traditional music, the approach of *Sonótronica* is to use technology as the instrument to learn music in the same way that a student learns music by learning to play piano or violin. This paradigm shift raises many questions about the musical language to be taught, the different kinds of instruments that exist, the right methodologies to apply, and the purpose itself of teaching and learning music in the 21th century. Some of those questions are answered using computer music programming languages. This report, which is based on five years of research, discusses computer music as a tool to expand the traditional definition of music that is generally used in music schools.

KEYWORDS: Music education, music school, live coding, contemporary music.

ORIGINS OF THE PROJECT AND BACKSTORY

It is mid-June and the summer is heating up the concert hall of our music school. Outside, around forty people are waiting for one of the many final concerts of this school year that teachers and students prepare for their families and relatives. Inside, the students are rehearsing and giving the final touches to an ensemble piece, only that, in this particular case, it is not a piece of a classical composer, but their own music, created collaboratively out of synthesizers, midi controllers, and computer code. They will soon play live on their laptops and various other gear in front of their parents and colleagues.

This is the dream[1] that motivated the creation of the course *Sonotrónica* at the public music school "María Dolores Pradera", located in the Chueca neighborhood in Madrid in 2018. Around three years before the opening, the City Council decided to invest some funding in an old, abandoned building in order to open it as a public music school for the district. Placed at the city center, in the same streets that witnessed the development of the *la movida*[2] countercultural movement in the 1980s, it seemed only natural that the school would boast an innovative program with a more contemporary approach. After some research, the City Council decided to focus on technology as the direction towards that goal.

The challenge was to avoid the creation of the usual course on music technology, where the students learn to edit digital music scores as a complement to their main traditional instruments. At the core of *Sonotrónica* lies the idea that technology could be understood as a musical instrument itself, opening many questions about which music to choose, and how to teach and learn it using technology in the context of a music school.

From 2018 until today, I have had the immense luck of teaching *Sonotrónica* at this music school and to reflect a great deal about it. My job as director gave me a broader perspective about it as well, since it let me see

1] Follow this url https://vimeo.com/794470849 to see a video where this dream has become a reality after five years of work. It shows a concert of contemporary music created or played by children, and where it is possible to see the participation of some *Sonotrónica* students.

2] La Movida Madrileña was a movement that, among other things, brought Punk and Synth-pop to the city's musical scene. To know more: https://www.theguardian.com/music/2020/feb/11/la-movida-madrilena-spain-post-franco-anarchists-alaska-pedro-almodovar the perspectives of the rest of the teaching staff, the families, and even the neighborhood. For me, to study the case of *Sonotrónica* is to witness one possible advance in music education in the same way that the introduction of popular music and modern instruments, like drums or electric guitars, have been incorporated into the classical musical training paradigm (Coppers & Berkers, 2023).

DESCRIPTION OF THE EDUCATIONAL SYSTEM, THE CLASSROOM, AND THE STUDENTS

During these four years the school has evolved to adapt itself to the arrival of new students. All public music and dance schools in the city network share the same system. This system has a defined structure to which any new instrument specialization must adapt.

There are three main stages in the public music system. The first stage consists of a four-year-progression for students between four to eight years old; the second stage, also with a duration of four years, serves students older than eight, and finally exists a more advanced third stage with a duration of two years, only accessible for students that have completed the previous stages. After that, a student may remain at the school by taking part in the various music bands and choirs on offer.

The second and third stages are similar for all instrumental specializations, including S*onotrónica*. All of these students have to attend a weekly hour of training of their respective instruments and a two-hour weekly course of music theory. At the third stage, the second weekly hour of music theory is replaced by collective playing in any of the music bands and choirs available.

Sonotrónica's students are grouped by age into two main groups at the second stage: a group of *children* from eight to ten years old whom we call *kids*, and another group from ten to thirteen that we call *juniors*. They typically stay two years in both groups so that they can dive deeper into the tools presented to them. While the *kids* group learns to make music with Scratch, Helm VST, Audacity or synthesizers like Korg's little bits, *junior* students learn Sonic Pi, Soundcool, MPC Beats, and to play gear such as teenage engineering PO 400 modular synthesizers, Arturia's drumbrute, or Korg's sampler sequencer. The classroom has laptops, headphones, and a midi controller for every student to use regularly and some touchscreen-based devices to use occasionally.

Students that apply for the course are usually technology enthusiasts; they are generally familiar with smartphones and tablets, but they need support moving from app-based applications to the personal computer. The first weeks of the school year need to be dedicated to the very basics of computer use, such as how to turn the computer on and off, how to save files and create folders, how to use a mouse, how to type with more than two fingers, and how to properly use audio cables and headphones.

The students' musical background depends heavily– and varies – based on the previous education and the exposure to music provided by their family, but in general *Sonotrónica students* have a preconceived idea of *what music is.* And thus, in order to use technology to make music, they need to also expand their definition of music. They must relearn *what music also can be*[3].

PROGRAMMING AS A COMMON LANGUAGE. LIVE CODING AS MUSICAL PRACTICE

This necessity of expanding their usual definition of music is key to understanding the use of technology in *Sonotrónica*. Usually, the curriculum of music theory that music schools offer in Spain is based on the traditional *solfège*. Modern music pedagogy, like the Orff *Schulwerk*, has refined the methodologies to make the process of learning music much more practical and hands-on, providing the students with a wonderful way of physically experiencing melody, harmony, rhythm, and the instrumentation of a specific piece. However, in general, they don't explore other musical languages developed in the 20th century much.

3] In German, for example, exists the term *Neue Musik* to speak about those new musical languages developed after World War II. It could also be called experimental music or contemporary music. In any case I mean music that is not made out of the traditional tone system. Although one could think that children of 8 years of age have not completely developed their idea of music, our experience is that although they are much more open to rare sounds, they have a clear and quick reaction to them as non-musical.

Without those musical innovations, the use of technology in music would be limited to the digitalization of traditional music: from editing music scores to recording, mixing, and producing music. But many musical innovations in the 20th century were born of technological innovation, like the tape recorder, the synthesizer, or the computer. So, using technology to learn music should also involve all of those instruments and bring with them all of their consequent exciting music innovation and exploration.

Electroacoustic music, electronic music, minimalism, computer and algorithmic music, experimental music, and soundscapes are based on music languages and theories that have not yet had the chance to be packaged in a time-tested system such as *solfège*, especially for children[4]. One main obvious obstacle of this is the lack of graphical representation of this music, some kind of score, that would allow us to visually study them, with some beautiful exceptions[5].

One possible way to circumvent this problem of a lack of literature and alternative scoring is by using computer code (Xambó, Freeman & Magerko, 2016). Code provides ways to design electronic sounds or manipulate audio recordings; it allows sequencing, remixing, applying effects or diffuse the sound in space, providing many ways to access a variety of innovative musical languages.

Another big contribution of programming languages is the possibility of performing music with computer code, live on stage. A vibrant international *live coding* scene supports it with many interesting examples of educational success. Live coding allows a student to analyze, learn, rehearse, create, and perform music based on cutting-edge musical discoveries and an aesthetic much closer to the sounds they usually listen to: music that would be very difficult to perform with a traditional instrument.

But the role of computer code in *Sonotrónica* is not limited to performing live coding. Computer code is our *new* solfège. Let's think about the creation of a sound object, for example. One could import an audio file into

4] Although only available in Spanish, in my final master work I researched about this by putting together a repository of books that had contemporary music or experimental music educational practices at international level. In it, I analyze up to 14 publications with lots of classroom activities: https://zenodo.org/record/4534134

5] Brian Dennis is one of the educators that cared to document his work with students in the form of scores with many instructions. His book "Projects in Sound", published in 1975 is a very good example.

Audacity and apply an effect to it to change its pitch. We could also edit it and remove, for example, the attack part of the sound. We could apply many changes and create a new, much more musically interesting, sound. Once it is done, we can export the new sound, and therefore we lose all the steps given to modify the original sound into the new sound, also losing the possibilities of repeating them, analyzing them, and balancing its role and its effect in the composition. If we replace this process with code, we can program the sequence of the instructions, and save them for later, so we could study them, make other modifications while listening to the multiple variations.

The ability to reference and reuse previous work applies to electronic sound design as well. We could use a certain preset on a keyboard synthesizer, or a patch on a modular one –both are well described and can be stored– but they are usually different from one machine to the other, forcing the students to relearn *exactly* how a certain patch works for a certain instrument, if even possible. With code you can have a general description of the process independent of the machinery and you can play it immediately.

The modular structure of computing code also makes it a tool to describe alternative musical forms and not just the individual sounds. It is easy to mix sound recordings with electronic sounds, and it allows us to sequence them in a range that goes from a completely sequenced and beat-oriented piece of music to a more organic or unstructured flow of sounds, which opens up for algorithmic thinking, which is also fun, for example, if applied to beatmaking.

A variety of well-known scores have even been transcribed into code with different levels of accuracy. Examples like Bach's *Minuet in G* (Aaron, 2014), *Aerodynamics* by Daft Punk (Rannou, 2015), Steve Reich's *Clapping Music* (Denton, 2015), the *Adagio in C major* for glass harmonica by Mozart (Newman, 2022), Deep Purple's *Smoke On The Water* (Codeforall, 2020), as well as exercises of Indian music (Kithan, 2020), show the potential of computer code as an alternative to staff notation. Furthermore, computer code can deal with computer-based representation systems of music, like MusicXML, that are increasingly being adopted by musicologists, since they allow defining a broader range of features present in contemporary sound creations.

REFERENCES INCORPORATED INTO THE EDUCATIONAL APPROACH

It takes a lifetime to develop a complete and coherent body of successful educational methodology. The main reference used in *Sonotrónica* is the STEAM approach. The revolutionary book *Mindstorms: Children, Computers and Powerful Ideas* (Papert, 1980) is a milestone in history. It suggested the use of computer coding in education for the first time. Through the creation of computer languages specifically designed for learning, children can develop their own computational thinking at a very early age through small, but increasingly complex, programming challenges.

The second reference for the *Sonotrónica curriculum* is the live coding movement, especially Sonic Pi, which is strongly linked to the education of young people, has many resources for the classroom. Those tutorials are frequently technically oriented. They focus on how to write code to express certain musical ideas, encouraging children to play with them in a creative way. But the live coding community knows what works best and that is the *Mexican approach* (Villaseñor-Ramírez & Paz, 2020), a practice developed in Mexico City around 2010 that helps to practice live coding as musical performance in *from scratch* meetings, which are sessions that follow a set of simple but interesting instructions. At *Sonotrónica* we have adopted this method as regular music practice in the classroom.

However, those methodologies on programming teaching and learning are simply not enough. Music learning is not only about technique and every music teacher knows that. We must develop the hearing, the creativity, the musical expression, and we do that by diving deeper and deeper into the artistic possibilities of a certain music language. This is typically done with the help of the selection of a meaningful repertoire. This is the real gamechanger.

In the context of *Sonotrónica*, a heavily used example of this kind of resource is the European-funded project *Ears 2: Compose with Sounds* by De Monfort University under the leadership of Prof. Leigh Landy. At the Ears2 website, music teachers can find many ready-made lessons about different kinds of sound-based music genres organized by their focus on listening, learning, and creating music. Their listening exercises help our students to learn how to listen to musical sounds, presented in an organized but expressive way.

The Ears2 project gathers repertoire of contemporary composers, explains the basic characteristics of their musical language, and proposes compositional exercises with a software tool called *CwS* that we adapt for Sonic Pi. Chance, drone, electroacoustic music, soundscapes, algorithmic patterns, or spectral music are some of the genres covered by their curriculum with truly genuine educational sensitivity.

The last reference of the methodology that drives *Sonotrónica* is the school and practice of free improvisation. We have had the enormous luck of having the Spanish pioneer Chefa Alonso teaching at our school for some years, and the impact of her ideas can be seen and heard everywhere. Free improvisation in the work of Alonso is all about playing with sounds and listening to others. She has written extensively about it in her books where there are ample activities that can be used in the music classroom.

While computers need some time to create expressive music collaboratively in the hands of children, common everyday objects, different materials, weird instruments, or the voice are an immediate interface for them to play with sounds together. And playing together is the ultimate goal of a music class.

FUTURE CHALLENGES

But *Sonotrónica's* program still has a long way to go. It needs a more defined curriculum and a repository of educational activities and resources. It also needs to design activities that help the collaboration of string ensembles, choirs, rock bands and wind orchestras with electronic sounds, algorithmic patterns, sequenced beats, and soundscapes. It needs more contemporary music scores composed with students and children in mind, that help them to expand and improve their musicality.

Just as art schools, music schools also need to be aware of their role in society. We need to present a more diverse musical context, enhance critical thinking towards the use of technology, raise awareness of the climate crisis, and exemplify the values of our societies with a more participative system for decision making, taking all voices, even students' voices into account.

The challenge of teaching music today is not the lack of electronic instruments or the need for new or more attractive musical ideas, but the understanding of the social function of art and technology in culture, and the responsibility of artists and musicians to make the world a better place. The

Sonotrónica program is taking the first steps in this direction. Being a school open to different music aesthetics attracts a different kind of student, and that opens the doors to a more diverse student body, which helps create synergies between new and old music and continues to raise needed questions about the meaning of learning and teaching music in the 21st century.

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5

Design of Digital Tools for Creativity Development through Sound Creation

DESIGN OF DIGITAL TOOLS FOR CREATIVITY DEVELOPMENT THROUGH SOUND CREATION

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ABSTRACT: This chapter presents a series of digital tools specifically designed by a team of researchers from the University of Valencia, in collaboration with experts and educators from different Spanish universities. The design of these tools is based on sound creation, where exploration and experimentation with sound are central elements for transforming educational practices in music towards more creative approaches. The tools are contextualised within the ARTSLAB of the Faculty of Education of the University of Valencia, a space dedicated to the integration of technology in an exploratory and experimental environment. This setting anticipates technological situations and uses as situated experiences, preparing future teachers to apply these practices in real educational contexts.

KEYWORDS: Digital Tools; Sound Creation; Sound-Based Music (SBM); Creativity; Software Design.

INTRODUCTION

Information and communication technologies (ICT) have entered the field of education with a functionalist perspective, conceived as a means to facilitate and speed up tasks. However, the vast majority of teachers lack in-depth knowledge and the ability to intervene beyond the use of interfaces. Teacher training in ICT has tended to focus on the use of specific devices and programmes, often taught by technology companies, without a clear pedagogical approach.

In only a few cases has technology been seen as a field for pedagogical experimentation, an invitation to design or co-design tools, to understand and modify the contents of their "black boxes", or to create one's own tools to accompany teaching and learning processes. In other words, most teacher training experiences in ICT have not used the experimental and transformative potential of technology in the classroom to create learning environments that allow for the acquisition and transformation of technological knowledge alongside the collective generation of pedagogical knowledge.

As Selwyn (2016) points out, the implementation of technology in education has been limited by an instrumental and functionalist vision that has left little room for experimentation and creativity. According to this author, 'digital education has become a massive classroom-centred, overly instrumental and prescriptive endeavour' (p. 36).

On the other hand, Friesen and Lowe (2012) highlight the lack of critical reflection on the use of technology in education. They argue that 'education should include the critical development of skills and knowledge to confront technological structures and emerging technologies that are constantly changing' (p. 6).

This problem-solving logic has created tensions and suspicions about the transformative potential of technology in the classroom, especially in critical educational contexts and cross-disciplinary areas that integrate democratic values into each area of practice. It is therefore crucial to support the construction of pedagogical knowledge based on collective practices that favour prototyping over linear processes.

The transformative potential of technological environments in education lies in "critical practices that democratise access to technological knowledge, opening up and contaminating analogical, ancestral, political, relational, ritual and poetic knowledge, promoting the appropriation of tools necessary for the emancipation of students and teachers" (García-Holgado et al., 2021, p. 1). This is achieved through experiences that allow for "networked technologies based on common needs, changes in use, hacks, repairs and technological creations that emerge from the poetic and go beyond functionality as the sole guide for technological development, becoming speculative tools for understanding contemporary art" (López de la Fuente, 2018, p. 2).

Furthermore, artistic practices are a way of generating knowledge and a powerful analytical tool for interpreting reality. According to López de la Fuente (2018), these practices are not limited to the popular STEAM or MakerED acronyms, but are nourished by an "epistemological pluralism to generate shared pedagogical knowledge from hybrid collaborations that connect educational practice and research with artistic creation and access to technological knowledge" (p. 3). In sum, the combination of critical practices, the creation of networked technologies, and the integration of artistic practice in education can contribute to more emancipatory education and the creation of shared pedagogical knowledge.

EXPERIMENTAL CONTEXTS FOR TECHNOLOGY INTEGRATION: ARTSLAB

There is a general consensus that the introduction of digital technologies has revolutionised the field of music (Bloustein et al., 2008), particularly in terms of accessing new ways of listening, sharing and creating music. Schools in many countries have incorporated digital technologies into their music teaching practices (Gall, 2012), often through music creation (Breeze, 2011).

Despite the creative potential of technology in music education, its use in the classroom tends to be largely limited to music consumption (e.g. listening to music or watching music videos), rather than taking full advantage of technology to enable synchronous or asynchronous collaboration between students (Partti, 2015, 2017).

However, these possibilities are not always fully realised in everyday school life, often due to teachers' limited competence in using digital tools for creative music-making (Partti 2014) and a limited understanding of what creative work in musical practice entails.

A key factor that is often overlooked is the design of spaces (classrooms) as places of experimentation, but a new design space is meaningless if its pedagogical pillars are not aligned with the practices that take place within it.

The design of new spaces allows for the redefinition and suggestion of other practices. Therefore, pedagogy and spaces constantly feed each other to facilitate new learning territories. The transformation of the classroom into a sound laboratory reflects a clear commitment to student-centred approaches to learning. Through more flexible spaces, the LAB situates practices in a kind of ongoing, unfinished project. Each project completion should be understood as a node that allows for connections with new projects. In this way, each project suggests or links to other proposals, encouraging new enquiries in a constant reordering of knowledge, for true knowledge lies in these imaginary intersections generated by processes.

Knowledge ceases to be dogma and becomes something alive, mutable and transformative. Over time, the result is a kind of complex fabric that is woven through our experiences, shaping and reinforcing any learning that is generated by the participatory and collaborative dynamics within these spaces. As Pardo (2014, p. 112) states: “Learning is a personal process, differentiated for each individual. For this reason, the spaces where learning takes place should not be monofunctional, but adaptable to the needs of each student”.

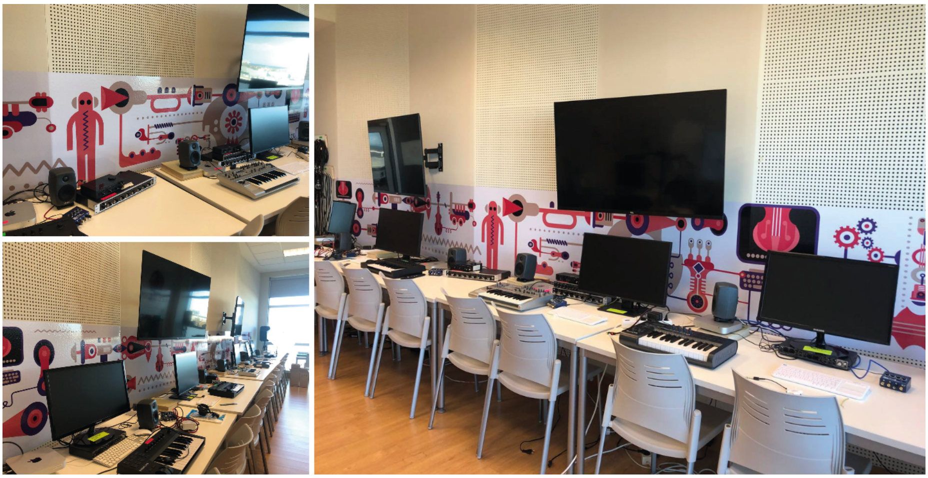

Fig. 1. Artslab digital space at the University of Valencia

The commitment to new spaces generates a different reality and helps to transform practices, as the laboratory creates devices to intervene in reality and allows for imagination and the recovery of utopia. In an interview by Vecchi (2010) with Carla Rinaldi, educator and director of the Reggio Emilia Municipal Schools, she affirmed: "Architecture has always had a very powerful role in our experience: since it configures pedagogy, it is one of the strongest influences. Therefore, when you create architecture, you actually renew pedagogy; architecture is not only the architecture of the building but determines and configures pedagogical architecture. From these perspectives, the notion of the laboratory emerges as a shared space for experiences and collective action, and it is the closest form to defining its practices and constantly evolving methodologies: the laboratory as a creation, meeting, and mixing device."

In order to take this concept of the laboratory further and to revisit it in a pedagogical discourse, it would be necessary to go back to the school of John Dewey. For Dewey, "[...] the laboratory school has the same relationship to pedagogical work as a laboratory has to biology, physics, or chemistry. Like any of these laboratories, it has two main purposes: to demonstrate, test, verify, and critique theoretical principles..." (Dewey, 1896, p. 436).

Thus, Dewey was convinced that most of the problems of dominant educational practices were rooted in a false dualistic epistemology between practice and theory. In his idea of the laboratory school, Dewey aimed to foster a social spirit among students and to develop their democratic character by organising them as a community.

Just as scientific laboratories demonstrate, test and verify theoretical principles, the school laboratory, according to Dewey, should do the same for pedagogy. In this context, the laboratory becomes a space that transcends the physical structure and becomes a dynamic environment in which pedagogy is constantly experienced and redefined.

Transforming the classroom into a sound laboratory proposes a significant change in the way learning is conceived. The flexibility of these spaces allows students to actively participate, explore, experiment and learn collaboratively. The constant connection with new projects and the adaptation to individual student needs reflect a deep understanding of the learning process as something personal and differentiated.

The notion of the laboratory as a place of encounter, creation and mixing emphasises the importance of interaction and collective action in the construction of knowledge. This approach reflects a contemporary perspective on pedagogy that recognises the diversity of learning styles and promotes a more inclusive and participatory approach to education.

Transforming classrooms into sound labs not only redefines the physical space but also reinvents pedagogical practices, promoting more active, collaborative learning that is tailored to the individual needs of students. It also enables teachers and researchers to reflect continuously on the practices generated and to move towards approaches where technology can better serve the needs arising from student interactions and the educational projects they develop. The actions that emerge from these projects represent real concentrations of knowledge that allow teachers to continually propose new strategies and links. In this way, the teacher assumes a new role that goes beyond mere transmission, becoming an architect of creative experiences and situations. Through collaboration and constant dialogue with the students, the teacher helps to uncover possibilities and resources that enable them to develop their own sound projects with freedom and autonomy.

However, and I think it is important to note, one of the aims of ARTSLAB is also to encourage and facilitate critical access to technology for our students. Therefore, the LAB does not aim to present different types of technology, but rather to facilitate their use in learning situations that somehow simulate what they might encounter in music classrooms during their teaching work, offering valuable opportunities tailored to the specificities of our students (Pérez, 2012, p. 94) and helping them to optimally develop their creative potential through sound creation.

Fig. 2. Experimental and analogical space of the Artslab at the University of Valencia.

The configuration of ARTSLAB has allowed the development of differentiated spaces where specific technologies can be explored and studied. It is a space where students are encouraged to engage with digital or analogue technology and where they can develop a more hands-on experience through interaction with sound objects. These activities encourage and promote the manipulation of all types of materials, generating a rich sonic imagination through acoustic experimentation and observation of the sonic responses offered by each type of material.

These multiple interactions, involving direct contact with the sound source, lead to an analysis of the material's behaviour; they help to generate and analyse different ways of making it sound, but they also encourage the development of students' curiosity as they explore beyond the classroom in search of sound objects with interesting features, stimulating creative approaches to listening.

We are therefore convinced that the design of such spaces, dedicated to the speculation and exploration of digital and analogue tools, goes beyond monofunctional classrooms. They allow an in-depth exploration of different programmes and digital tools. In this case, the students have access to computers in the classroom, distributed in groups of six, and to keyboards that allow the application of complex processes of sound transformation. Using digital tools, sounds are stretched, twisted, inverted and constantly transformed to the point of becoming unrecognisable. However, this can become an empty exercise if we, as teachers, do not encourage and provide spaces for reflection. As physical spaces change, so must our ways of operating within them.

As Galetto and Romano (2012, p. 56) state: 'The mere act of observing (listening) or experimenting, although optimal for motivation, does not generate knowledge construction or a conceptualisation process. What matters about phenomena, beyond surprising us, is not only their aesthetic or 'magical' aspect, but also their logical phenomenology, the network of connections that can be built. This happens not in the experience itself, but in the reflection on the experience.'

Therefore, it will be necessary to develop dialogical strategies in which each process involves a constant review, together with our students, of our own beliefs and observations. Collective debate must replace directional teaching based on the single discourse of the teacher, in order to open up from debate to the multiplicity of different meanings produced in the classroom.

SOUND AS A CREATIVE TRIGGER

In recent years, studies focused on sound have experienced significant growth (Thibeault, 2017). These studies are based on multidisciplinary approaches that include fields such as acoustic ecology, sound design, soundscapes, anthropology of the senses, history of everyday life, environmental history, cultural geography, urban studies, auditory culture, musicology, ethnomusicology, literary studies, and science and technology studies. These studies can be highly relevant to informing processes related to sound exploration, creation and listening.

However, early studies of sound treated it as an isolated object or event, separate from the listener. As O'Callaghan and Nudds (2009) point out, according to science-filtered common sense, sounds are simply travelling waves (p. 7), or what O'Callaghan (2009) calls the "wave view" (p. 27). These waves are produced by a physical body and can therefore be interpreted as secondary properties of that physical body, or what is called the "property view" (O'Callaghan, 2009, p. 27). Thus, these definitions could be seen as limited because they do not take into account the listener.

The study of sound not from the perspective of its source but from the perspective of its perception, commonly known as "phenomenology", examines the perceptual aspect of sound. The first is an "individual" phenomenology (Chion, 1994, p. 81) of listening, which holds that "sounds are subjective and private, and there is an auditory perceptual access to the world" (O'Callaghan & Nudds, 2009, p. 5).

However, some scholars have suggested that Western thought has traditionally been "ocularcentric" or "dominated by vision" (Jay, 1993, p. 3). As the historian Jay (1993) points out, metaphors such as Plato's allegory of the cave, the Enlightenment, Descartes' fixed mental gaze, and Foucault's (1972) panopticon and medical gaze suggest that Western philosophy has privileged vision over other senses. Philosophy, he argues, "has tended to unquestioningly accept the traditional sensual hierarchy" (p. 187). Although Western thought has privileged vision over other senses, ocularcentrism has its limits.

Auditory perception reveals the world in ways significantly different from vision. As Idhe (1976) notes, "an investigation into what is audible is also an investigation into the invisible. Listening makes the invisible present similarly to how the mute is present in vision" (p. 51). Listening allows individuals to access forms of knowledge and perception unavailable through sight. "This deliberate shift in emphasis from the visual to the auditory initially symbolizes the hope of recovering the richness of primary experience, now forgotten or hidden in overly narrow interrelated visualist traditions" (Idhe, 1976, p. 14). Goodman (2010) expands this study of the invisible to include all things. He suggests that the study of sound allows access to the broader phenomenon of vibrations, of which sound is a subset. "Except for human perception, everything is in motion. Anything that is static is only so within the realm of perceptibility. Molecularly or quantum-wise, everything is in motion, vibrating" (p. 83).

As Thibeault (2017) argues, delving into sound studies can provide music education with "a deeper understanding of ways to comprehend sound and music beyond the approaches commonly found in music schools, particularly those that limit their understanding of music to music history, music theory, and music psychology" (p. 58). From a critical-historical perspective of sound, it provides ways to situate and explain movements in music education, as well as the participants' beliefs about the act of listening and the musical experience (Abramo, 2014).

According to Toop (2017), "Sound-based music relies on the exploration of sounds themselves and the relationship between them." This approach focuses on sound texture and density rather than traditional melody and harmony. Composer and teacher Pauline Oliveros has been a significant figure in the development of sound-based music. She has stated: "Sound-based music refers to the exploration of the nature of sound, attention to the details of sound, and expanding the boundaries of what can be considered music" (Oliveros, 2019). Sound-based music is related to electroacoustic music and *musique concrète*, as both focus on the use of recorded and manipulated sounds. According to Collins and d'Escriván (2014), "Electroacoustic music uses electronic means to generate, transform, and manipulate sounds, while uses recorded sounds and then manipulates them."

In sound-based music, the emphasis is on exploring sounds themselves and how they relate to each other. According to Toop (2017), "Sound-based music offers the possibility to focus on the listening experience, explore new sounds, and establish new relationships between sounds."

These perspectives on sound have led to new approaches in music education that depart from a more traditional view centered on musical notes, enabling people without prior musical knowledge to create and transform their own music through technology (Holland & Chapman, 2019). As Delalande (2008, p.19) notes, the democratization of early technologies and their creative uses has shaped new ways of accessing and creating music, becoming a "tool for composing."

As Kaschub & Smith (2014) and Dwyer (2016) suggest, teacher candidates with training in Western music may have little knowledge of other styles, which may be inappropriate for teaching music in the classroom. As previously mentioned, this type of teacher training generates certain tensions by showing musical experiences disconnected from students' interests (Allsup, 2008, 2016; O'Neill, 2015), where musical goals are prioritized over educational ones (Regelski, 2012, 2017).

The variety of technological tools at our disposal has made it possible to work almost surgically with sound. These possibilities have enabled new approaches to sound creation. The boundaries between consumers and creators have blurred, giving rise to a much more active citizenry that is seeking strategies to participate in the musical act in ways that were previously unimaginable. These new profiles, which some authors call "prosumers" (Toffler, 2004), refer to citizens with the ability not only to consume culture, but also to produce and share it.

In addition, the use of technology in the music classroom has increased student motivation in the teaching and learning process (Wang et al., 2022) in relation to the possibilities it offers for sound transformation. However, its potential for sound transformation has been under-utilised.

Better implementation outcomes could be achieved through school innovation, where teachers are trained in new tools that allow them to approach music learning in a more creative and participatory way for both teachers and students (Wolf & Younie, 2019). From a more creative perspective, digital tools applied to sound have made it possible to approach music in ways that were unthinkable just a few years ago, and have to some extent democratised the creative act (Ruthmann et al., 2015).

In this line, the Sound-Based Music (SBM) approach focuses on the use of sounds and how they can be transformed and manipulated to create music. Sound-based music is a general term used to describe music in which sound, rather than notes, is the primary unit (Landy 2007, 2012). In this sense, Cage also referred to the loss of the physical relationship between the musician and the sound, encouraging a more 'epidermal' relationship beyond the written note.

DESIGNING DIGITAL TOOLS FOR SOUND CREATION

In order to encourage a more exploratory, experimental and creative approach among undergraduate students, several digital sound creation tools have been developed.

In this section, we will briefly present the different programs that have been developed by our research group, which are aimed at experimentation and sound creation based on the Sound-Based Music (SBM) approach.

The three software programs presented here were born out of the idea of expanding the possibilities of sound creation in different areas where there has been a lack of digital applications to support aspects such as collaborative creation, soundscapes or experimentation with objects conceived as musical instruments.

In this sense, these three software programs have been created, each of which aims to develop the above concepts:

1. **Aglaya Play**: A software for collaborative music creation.
2. **Acouscapes**: A software for ecoacoustic education and soundscape composition in primary and secondary education.
3. **Imaginary Play Box**: A software for sound experimentation through the digital manipulation of objects.

1. *AGLAYA PLAY: A SOFTWARE FOR COLLABORATIVE MUSIC CREATION*

Aglaya Play is a software designed to address three basic needs in music education: the inclusion of creative processes, the adoption of collaborative-cooperative strategies, and the reduction of reading, writing and theory. Learning in the early stages of music education takes place through much more intuitive work involving manipulation, experimentation and creation with sound as the primary element (Murillo, et al., 2021).

1.1. *DESCRIPTION OF AGLAYA PLAY HOST*

APH is an application programmed with Max-MSP software (Cycling' 74 and IRCAM 2019), compatible with both MacOS and Windows. Max allows the user to write fragments and compile them as executables. APH functions are divided into modules. These modules can be controlled by a mobile device (smartphone/tablet). The control function is managed by the specially designed APM application. In the AP system, APH modules receive OSC control messages from APM.

APH modules include Sampler, Multisampler, Creative Transformer, Keys and Instrument. Each module is designed to produce performative actions through real-time control from mobile devices or direct control from a computer. The next section shows the GUI for each module. In typical creation processes with APH, we take a holistic and contextualised approach, using almost all of the modules. In this sense, in addition to providing performative live solutions via mobile device control, the software can be used to create a small laboratory for sound experimentation and creation by combining different modules.

Fig. 3. Aglaya Play software graphical interface

1.2. *DESCRIPTION OF AGLAYA PLAY MOBILE (APM)*

APM is an application written in Unity for mobile devices (smartphones and tablets) running iOS and Android operating systems. Its function is to control the following computer-based APH modules: Sampler, Multisampler, Creative Transformer, Keys and Instrument, which can also be used for performances as mentioned above. Each of these modules is displayed on the device's screen, and by tapping or clicking, the user can explore the modules and experiment with sounds.

Fig. 4. OSC control of Keys and Sampler modules from mobile devices

2. *ACOUSCAPES: A SOFTWARE FOR ECOACOUSTIC EDUCATION AND SOUNDSCAPE COMPOSITION*

Acouscapes is software designed as a simple educational solution for creating soundscapes and using them in sound-based music composition for primary and secondary schools. The software provides slots where users must place the sounds that will compose the desired soundscape, allowing for interactive sound journeys by interacting with the graphical interface. Acouscapes allows users to modify the content of these soundscapes through sonic and structural editing and includes a recording function (Tejada, et al., 2022).

2.1. *DESCRIPTION OF THE SOFTWARE*

The right side of figure X shows the graphical element that allows the user to select different perspectives in a multi-source sound environment. The nature of this environment is configurable through a simple drag-and-drop action, whereby audio files from each selected source are placed on one of the twenty coloured circles that make up this element. Once the sound sources are loaded, the user can place the cursor anywhere on the screen to obtain a sound mix composed of the sounds that form part of the intersections of the circles on the screen.

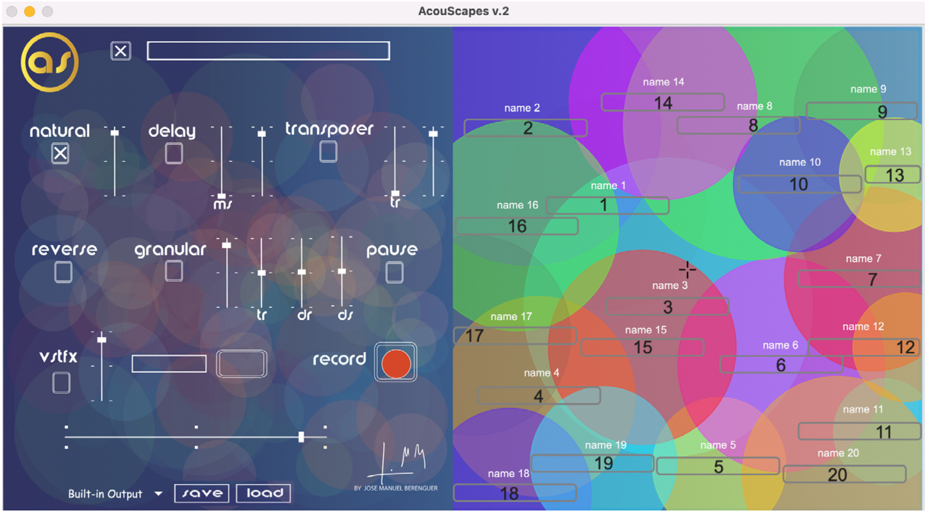

Fig.5. Acouscapes software graphical interface.

On the left-hand side of the image are various elements that allow further sound manipulation, with the possibility of recording the effects applied in real time.

3. *IMAGINARY PLAY BOX: A SOFTWARE FOR SOUND EXPERIMENTATION THROUGH THE DIGITAL MANIPULATION OF OBJECTS*

The Imaginary Play Box software is designed to connect the Play Box instrument to the computer's audio input (WIN/MAC) or to an external audio interface, such as a contact microphone placed on a surface or a conventional instrument. The Play Box (PB) instrument, for which this software was originally designed, is an acoustic box whose visible elements can be manipulated in various ways to produce a variety of sounds. The PB contains a set of materials, mostly metal (springs with different tensions, a musical mechanism consisting of a cogwheel with a crank, a scraper, metal sheets with different tunings, spirals, elastic bands with different tensions, etc.), which facilitate sound action through physical manipulation and/or activation with mallets of different sizes and materials (rubber, felt, wood), with the aim of exploring and generating new timbres. The box design also includes an audio jack output that can be routed to an amplifier, effects pedal or, in this case, the Imaginary Play Box software.

The purpose of this software is to expand experimentation possibilities from physical manipulation and later transfer them to a digital system, thus enhancing the process of sound exploration and experimentation (Murillo & Riaño, 2023).

3.1 *SOFTWARE DESCRIPTION FOR IMAGINARY PLAY BOX*

The software design simulates a series of effect boxes with the ability to incorporate external sounds while simultaneously manipulating and digitally transforming sounds from an external source. In this context, the Imaginary Play Box is positioned as a tool for creative exploration, allowing the user to experiment with different effects and digital resources that allow a deep transformation of sound, initially of acoustic origin.

The software's functions are divided into different sections or modules, such as Granular, Delay, Reverb, Bandpass, Bank, Looper, Record and an external sampler.

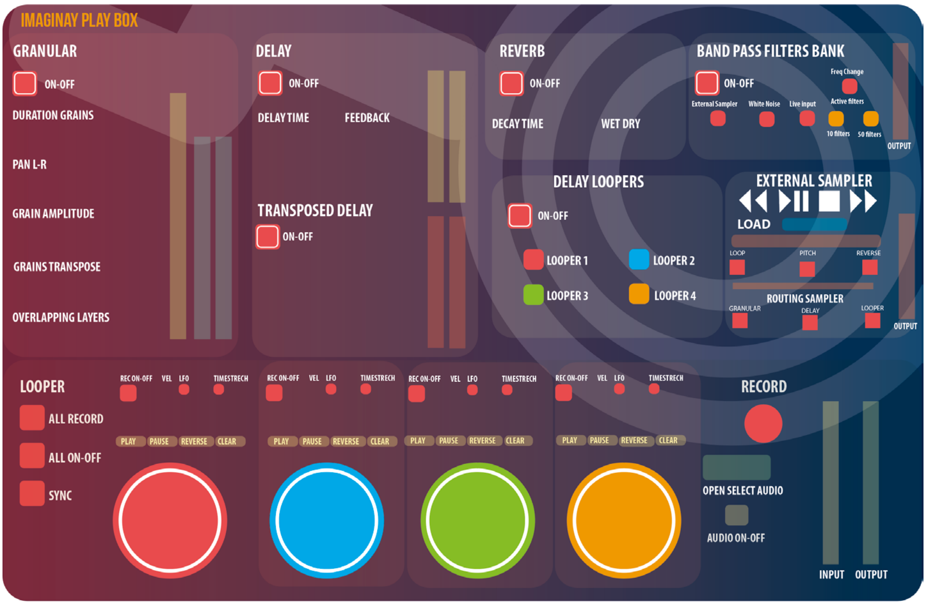

Fig. 6. Imaginary Play Box graphical interface.

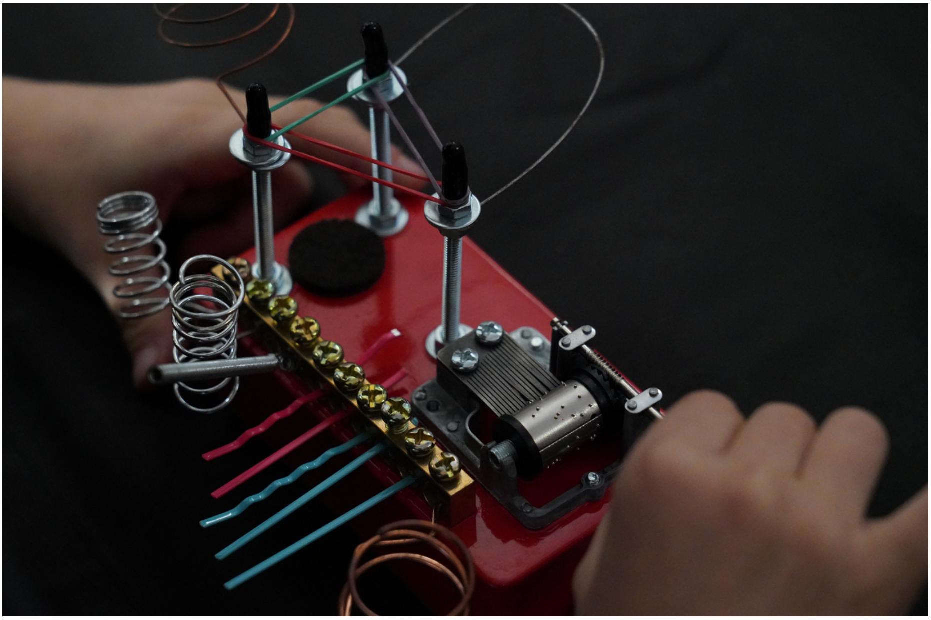

Fig. 7. Play Box sound artefact for use with Imaginary Play Box software.

In addition, to facilitate the integration of multidisciplinary content, the External Sampler module allows the loading of external audio, such as narrations or a sound base, which can then be synchronised, mixed or combined with sounds from direct Play Box intervention to create new and original proposals.

RETHINKING THE FUTURE

The development of digital tools for sound creation, as presented in this chapter, represents a significant advance in the field of music education and creativity development. Through the implementation of programs such as Aglaya Play, Acouscapes, and Imaginary Play Box, it is possible not only to democratise access to music creation, but also to promote collaborative and experimental learning that transcends the limitations of traditional music pedagogy.

First, these digital tools have been designed with a focus on sound exploration and manipulation, moving away from more conventional approaches centred on reading music and music theory. This paradigm shift, based on the philosophy of Sound-Based Music (SBM), redefines the concept of creativity in the classroom by allowing students to interact directly with sound as a plastic material that can be transformed and manipulated in many ways. The flexibility of these software tools not only facilitates collaborative creation, but also allows users to explore the acoustic and digital dimensions of sound, generating new forms of musical expression.

Secondly, the integration of these tools in experimental educational contexts, such as ARTSLAB at the University of Valencia, has demonstrated that environments designed for technological experimentation promote more active and meaningful learning. These flexible spaces allow for a pedagogical approach that is more responsive to students' needs, placing the sound experience at the centre of the learning process. The concept of a sound laboratory emphasises the importance of learning that not only involves the acquisition of knowledge, but also encourages critical reflection on the technologies used and their pedagogical implications.

Based on this pedagogical philosophy, the tools shown to future teachers enable them to develop critical and creative technological skills, which are essential for designing educational activities that effectively integrate technology in the classroom. The digital tools described here facilitate an immersion in sound creation from a playful and accessible perspective, which is particularly valuable in educational contexts where access to formal musical training is limited.

Finally, interdisciplinary approaches to sound creation open up new avenues for music education, where the boundaries between creator and consumer of music are blurred. Digital tools promote the figure of the 'prosumer', facilitating participation in cultural and musical creation. In this context, technology is not just a functional tool, but a gateway to new forms of knowledge and artistic expression, stimulating both teachers and students to explore and redefine sound as a catalyst for creativity.

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6

The minimalist cat and electroacoustic critical pedagogy

THE MINIMALIST CAT AND ELECTROACOUSTIC CRITICAL PEDAGOGY

ANALYZING THE POSSIBILITIES OF ELECTROACOUSTIC MUSIC IN ART PEDAGOGY THROUGH A CASE STUDY

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ABSTRACT: In 2022 we, the theatre pedagogue and sound artist Nóra Varga with the sound designer and musician Petri Kärkkäinen, collaborated to develop a sound art workshop for the adolescent participants of a theatre themed summer camp in Helsinki. 15 participants with diverse background, between the age of 12 and 16 formed three smaller working groups and took turns to experiment with electroacoustics, movement, and an overhead projector created shadow theatre with. In our research we analyze the workshop from four points of view. I, The applied technology, its accessibility, familiarity, and novelty. II, The meaning of sounds, agency, and self-expression. III, Community autonomy and social interaction inspired by technology. IV, The challenges of the workshop method and some possible suggestions to improve the workshop.

KEYWORDS: Art pedagogy, critical pedagogy, sound art, community.

During the summer of 2022 we, the theatre pedagogue and sound artist Nóra Varga and the sound designer and musician Petri Kärkkäinen, collaborated to develop a sound art workshop for the adolescent participants of a theatre themed summer camp in Helsinki. The aim of the session was to experiment with interdisciplinarity and with the possibilities of live electroacoustic improvisation to provide creative musical agency for the students. 15 participants with diverse background, between the age of 12 and 16 formed three smaller working groups and took turns to experiment with electroacoustics, movement, and an overhead projector (shadow theatre). In the workshop, after familiarizing with the different possibilities and a short group-rehearsal time, the students were asked to improvise together. The group with the overhead projector followed the lead of the electroacoustic composition team and time to time they switched their dynamics, and experimented with creating in symbiosis.

As soon as a participant makes a connection to the music – for example through having the agency of manipulating, organizing, choosing and or creating the sound – the experience becomes empowering for the student (Regelski, 2004). This empowerment could lead to other meaningful musical experiences within or outside of the workshop or school (Abrahams & Head, 1998). How could electroacoustic composition offer a democratic ownership of interdisciplinary creation? In what ways did the workshop technique empower the participants? In our research we analyze the questions from four points of view. I, The applied technology, its accessibility, familiarity, and novelty. II, The meaning of sounds, agency, and self-expression. III, Community autonomy and social interaction inspired by technology. IV, The challenges of the workshop method and some possible suggestions to improve the workshop.

Classical music education (music classes that focuses on the classical canon of Western music and teaching musical notation reading) has been criticized for years mainly for not being able to connect with the students, not being able to "make a change" in the student's life, lacking culturally responsive teaching (Campbell & Lum, 2019, p12), or having a highly Eurocentric approach (de Quadros & Amrein, 2023). As opposed to the hierarchical traditions of Eurocentric music pedagogies, another approach, critical pedagogies, has appeared in the past few decades.. This societal and pedagogical praxis and theoretical approach has been discussed and applied more and more often connected to new ways of music education. Critical pedagogies are based on the Foucauldian idea that the hegemony of traditional knowledge and truth should be questioned, and on the pedagogy of the oppressed by Paolo Freire (Freire 1970), where the goal is to create the counter hegemony of the oppressed, the resistance rethought and practiced, classical theorists of critical pedagogies are for example Apple, Giroux and McLaren (see Apple, 1982, Giroux, 1988 and McLaren, 1995). Abrahams describes the ideal goals for music education that is based on critical pedagogies as a pedagogical method that aims for broadening the students' view of reality, is transformative, is a conversation, reflects to the political aspects of power structures in the classroom and empowers the students. Abrahams calls for a music education that is not just about recalling information, but most importantly "includes understanding and the ability to act on the learning in such a way as to affect a change" (Abrahams, 2007, p3). Taking critical pedagogies as their starting point, James Banks in their book, *Multicultural education: Historical developments, dimensions, and practice* categorizes five dimensions of multicultural education: (1) content integration, (2) the knowledge construction process, (3) prejudice reduction, (4) equity pedagogy, and (5) empowering school culture and social structure (Banks, 2004, p. 5). Equity pedagogy is the application of various pedagogical methods in order to facilitate the participation and learning of students who belong to diverse socio-cultural and ability groups. This dimension is aligned with our intentions of choosing an electroacoustic music focused workshop. New Theatre Helsinki, the project behind the workshop, offers theatre workshops for teenagers with diverse backgrounds and believes in a theatre that subverts the traditional hierarchies in theatre and in other art forms. With our colleagues, we have noticed that there is a strong need in our students to experiment with sound and music. For this reason, we started to work together on a workshop plan that is accessible without further musical knowledge, empowers the participants and encourages them to explore sound. The classical, master-apprentice based instrumental music pedagogy maintains lot of traditional hierarchies. It is often unable to take other musical value systems into consideration, and it is marginalizing students who have a different understanding and values regarding music (Campbell & Lum, 2019, p14). We believe that it depends of course on the pedagogical methods of the teacher,[1]

1] The possibility to use acoustic instruments in public education is not given in every country, therefore I would like to emphasize the differences between the two educational systems I experienced. In Finland, in music classrooms there is encouragement and the option to try out different acoustic instruments, in Hungary most of the public education institutions cannot afford to provide instruments. Partly for this reason the but classical music scene is still quite conservative, and as Sanna Kivijärvi and Pauli Rautiainen emphasize in their study, the change should not fall exclusively on the shoulders of the individual music teacher, but should rather be the responsibility of the school system (Kivijärvi & Rautiainen, 2021, p 103). The traditional concept of playing on an acoustic instrument meaning years of disciplined learning, maximum control and the ability to read music was something our students discussed about prior to the workshop. Besides these, There is also elitism and use of jargon in the Finnish music education system. (It was analyzed by Väkevä & Westerlund & Ilmola-Sheppard, 2022).[2] When we mentioned theatre sound and music in the summer camp, the first thought of the workshop participants was that we learn to play acoustic instruments and create an orchestra, or a band. Our main motivation to choose the methodology was to develop the creative musical expression of the members of our diverse group and to provide an accessible way for that. Could electroacoustic music be the preferrable solution? Tim Cain emphasizes the importance of including electronic (and electroacoustic) music in the curriculum, especially because it is accessible to marginalized children as well, and because it is connected to the technically intertwined world the students are living in. For these reasons most of the students engage enthusiastically with this approach. (Cain, 2004). This conclusion is in line with our experiences as well. On the other hand, Cain expresses their concern about electronic music in the classroom lacking

Hungarian system is more focused on music theory and singing, while keeping strict hierarchies, In Finnish public education, inclusion is an often-discussed topic, it is represented in studies about music education and in practice as well. See more about the matter in the article of Sanna Kivijärvi and Pauli Rautiainen, Contesting music education policies through the concept of reasonable accommodation: Teacher autonomy and equity enactment in Finnish music education (2021).

2] In Finnish public education music education is part of the school curriculum (at least between grade one and seven). Besides this there is an option of taking part in complementary music education provided by music schools. As the ArtsEqual research project pointed out, music schools are often accepting new students based on an application system that is effected "by a variety of structural factors, including age, gender, habitat, and choice of instrument and/or genre or area of living, but also by economic status, ethnicity, culturally marginalised position, non-citizen or immigrant status, and disability–all traits that may be judged as potential in terms of determining merit." (Väkevä & Westerlund & Ilmola-Sheppard, 2022, p 421).

groupwork and mentions that music teachers have criticized the lack of singing that trains the aural capability of the participants (p 219). Jeffrey Martin criticizes ICT (information and communication technology) in music education for focusing too much on tonality (still strictly connected to Western musical traditions) and dismissing the other possibilities of sound, therefore denying the students' access for the work electroacoustic communities has been doing for over decades (Martin, 2013, p 102-103). The aspects underpinned by Martin, Cane, Regelski, Abrahams and Banks were important markers for us. Especially because we wished to create a workshop that a) acknowledges the participants' agency, b) focuses on live art c) aims for cooperation d) doesn't require any further knowledge, since every single student is treated as an expert of their own experience and e, undermines the hierarchies) f) encourages the participants to think about theatrical sound further than the traditional (taught in school) concept of music. As Mario Alberto Duarte-García and Jorge Rodrigo Sigal-Sefchovich in their study about teaching electroacoustic music in rural communities argue, besides the excitement and engagement of the students, electroacoustic music is an accessible and easy to engage with form of music education that enhances social integration and doesn't necessarily require an expensive technical toolkit (Duarte-García, Sigal-Sefchovich, 2019). Accessibility and creative engagement were more than important for us as well.

The dramaturgy of the workshop was the following: we created three smaller groups of the students. Meanwhile one of the teams explored the possibilities of the keyboard the other group experimented with an overhead projector, listening carefully to the sound team. The third group was improvising with movement, not always in connection to the sound). After the short exploration phase the three groups were united. The movement group became the audience of the shadow theatre group and the sound groups, who improvised a piece together.

I. **THE APPLIED TECHNOLOGY: ITS ACCESSIBILITY, FAMILIARITY, AND NOVELTY**

The workshop aimed for exploring electroacoustic music that is not based on the rules of rhythm, melody, harmony and meter and is created by using recorded and transformed sounds, initially we were inspired by *musique concrète* and its pedagogical possibilities.[3] In choosing the suitable technical tools, several different factors played a key role, such as simplicity, tools designed to perform well in live circumstances, intuitive use, accessibility, etc. Petri Kärkkäinen opted for Arturia Keylab midi controller and Ableton Live software. Ableton Live has the reputation of being used in live circumstances and it is possible to do modifications meanwhile the program runs. From this perspective, Ableton Live was more suitable for our needs than for example Pro Tools, which is an industry standard when doing sound editing for video or mixing pre-recorded music tracks, but doesn't lend itself that well into live situations where realtime manipulation of loops and sounds and seamless playback are crucial. When working with a group of students (of diverse background), time plays a key role. On the other hand, there are some obstacles in using Ableton Live in pedagogical context: for example the software is not completely free (although, there is a free trial). Besides this, it also requires some time to familiarize with the tool. Depending on the different educational systems and resources, it might be overwhelming for a teacher to learn to use the tool, even though after understanding the main concept of the sotware the work put into learning pays off. Given the rapid rate of technological progress, different sound editing softwares are becoming accessible to the everyday phone and computer users. According to Regelski, getting familiar with the technical tools our students are using is needed in order to make a difference in the students' life, therefore it is part of the ethical obligations of the teachers to do so (Regelski, 2012, p 19).[4] Ableton Live has infinite possibilities to do anything

3] Musique *concrète* is a genre of electroacoustic music, pioneered in the 1940s' by the likes of Pierre Schaeffer. It uses sound recordings of non-musical sound sources as raw material, and doesn't rely on the normative musical rules regarding rhythm, harmony and melody. "Known as *objets sonores*, these components formed the basic materials for composing *musique concrète*. The functional characteristics of the technology thus materially influenced the art and craft of *musique concrète*, in terms of both the creative working environment and the acoustic quality of the results." (Manning, 2003, p 6).

4] Although, we believe that it should not necessarily be the responsibility of the pedagogue, but also a systematic matter. In Hungary for example the teachers are overworked and exploited by the educational system. Based on the newest legislation (active from January of 2024) they could be obliged to work 48hours weekly and required to teach 24 classes a week.

with the sounds inside the session and it was pedagogically important for us that we narrow down the options for the students. The use of an external midi controller, Arturia Keylab, helped us with this since we could choose a few simple parameters such as volume and pitch and assign their control onto tactile, physical knobs and faders on the Keylab which the students could turn and twist with their hands. This way the manipulation of sounds, which was now more connected to the students' physical reality, became also more intuitive.

Arturia Keylab has some visual resemblance to a piano keyboard, and while its familiarity could encourage participation, there is also the danger that students associate it to certain ways of playing music. Based on our experiences the children immediately started to experiment with the keyboard. As soon as they started to create, they realized that 'playing on the keyboard' doesn't require any previous knowledge. Despite of the expectations of the students, the keys didn't have a big role as there was just one sample out of many that was controllable by them. The less instrument-like faders and knobs of the controller played a bigger role. For the workshop, Petri Kärkkainen had pre-programmed three sets of soundscapes consisting of various pre-selected sounds. The sounds in all three sets were separated into different categories, and were marked by a pictogram drawn next to the fader controlling each individual category. It was crucial that the labels of the categories are not musical terms and they are not language based terms either. The categories were the following: 1, nature sounds (ambience, wind, forest) symbolized by a tree drawing, 2, human made sounds (breathing, footsteps) marked by a human figure, 3, animal sounds (cat purring, whale) symbolized by a cat pictogram, 4, vehicle sounds (car, plane, traffic) symbolized by a car and 5, pop songs (Bohemian Rhapsody, Frozen theme song, Lion King theme song) symbolized by musical notes. Category number 6 was not a pre-selected sound but instead the students could record a sound of their choosing on the spot and use it in the soundscape. This category was marked by a microphone drawing.The aspect of having audio content that the students recorded themselves was also meant to give more agency to the participants and make the end result more interesting by making the process more unpredictable. In case of the pop songs the participants had a chance to manipulate and distort the songs by "playing" the recordings on the pianolike keyboard of the Keylab. The keyboard controlled a granular sampler into which the songs were imported, and by experimenting with the piano keys the students could have portions of the song play back lower or higher in pitch, slower or faster, or all of these at the same time.

The students could manipulate the sounds in beforementioned categories further by engaging with the modular wheel and the pitch wheel of Arturia Keylab. Turning the modular wheel created an "underwater effect" into the overall sound, which was achieved by a simple equalizer plug-in and assigning the modular wheel to control the cutoff frequency of a low-pass filter. The pitch wheel changed the pitch of the overall sound up or down. The cutoff frequency is a perfect example for another special feature of electroacoustic music that Odam & Paterson mention as well: the students can create music that it is not possible to play on acoustic instruments (2000, p 19). With the wheels, the students were able to create continuous variety. The logic behind the choice of sounds and their categorisation was to have enough diversity in the nature of the sounds. The students would have to deal with both ambient, non-evolving sounds such as wind, b), and also sounds with heavy transients -and therefore a relation to time- such as footsteps. It was also important not to have all the sounds occupy the same frequency spectrum but instead have "higher" and "lower" sounds. Humor and familiarity was also a key factor in choosing the sounds: some of the sounds were more abstract and some more easily recognizable, some darker in mood and some more humorous. For example the ability to manipulate well known pop songs or recordings of the student's own voices added to the humorous side of the workshop, and through that hopefully to the student's motivation. One of the three groups wished to record all the sounds they use themselves, but unfortunately we had no time to do so. It could be a great idea to develop the workshop further, or better say maybe as a continuation, so the students already understand the logic: the application of a variety of transient, abstract, etc. sounds. The obstacle of using this kind of equipment is that special guidance is needed: a facilitator who helps the students and encourages them to explore and work with the set, and who is able to solve smaller technical difficulties. In the workshops we faced another challenge even though the equipment was quite simple, versatile and mobile.We had the workshops in an old building and occasionally the external controller couldn't get enough power from the old sockets that led to a temporary confusion and restarting of the system. Another obstacle of the workshop was the lack of equipment. We prepared one set, partly due to our resources, partly due to the lack of space. We had 15 students participating, therefore in one group there was 5 students working together. 5 persons for one equipment is quite many, there is a danger that some of them gets overexcited and doesn't give space to the others to experiment. The composition created by the group was a teamwork. They needed to listen to each other and they improvised together, which creates a learning experience based on cooperation and adaptation (Heble, 2010, p 18). The groups shared the time and the equipment and they tried their best to include everybody's ideas, but if someone wanted to step back, they could do so. An alternative version of the task could be that several person's manipulation is needed at the same time: there could be multiple controllers to be shared among the participants for example. For the visuals we used an old, portable overhead projector, Traulux 2500P, pipettes, water, food colours, coloured foil, fake hair, recycled materials, and a glass container.

In the first round the sound group improvised together, meanwhile the overhead projector team experimented within their own group. After finding some elements they wanted to develop further, the two groups (the one using the overhead projector and the one who was experimenting with sound) had an improvised piece together witnessed by the third group whose members could join in with some movement, but they mainly decided to watch the piece. The instruction was to concentrate on their group members and the other group, to try to react and be inspired by the other group's actions.

II. THE MEANING OF SOUND, TRANSFORMATION, AND SELF-EXPRESSION.

The group members came from relatively different backgrounds. Some of them were socialized in the Finnish educational system, but some members of the group had been studying in private education or abroad before. Some adolescents had experiences from the above-mentioned music school system. Others had no familiarity with acoustic musical instruments. When we first mentioned the idea of a sound workshop facilitated by a sound designer, almost all of them got excited, with some exceptions: some students clearly stated that it was a really 'foreign ground' for them.. They asked follow-up questions about why we use the word *sound* instead of *music*. To use the term *sound* instead of *music* was a conscious decision to avoid associations leading towards music school classes and playing on acoustic instruments. The workshop happened in a theatre focused summer camp, where some participants knew each other, but approximately half of the group were new in our community. It was important for us to fully focus on sound, and then expand it to an audiovisual discourse between the sound compositions and shadow elements. Improvisation and ephemerality played a crucial role in the workshop, both qualities that are crucial to live art. The setup managed to create a welcoming ambience where it was relatively easy to join in. Exploring electroacoustic music compositions doesn't necessarily require previous knowledge, as it focuses on non-traditional characteristics of the sound and inspires the practitioners to interact with their surroundings in a playful way (Schaeffer, 1966). This approach is encouraging the involved participants to listen, organize and modify. We have noticed that the participants of our workshop had curiosity to try out all the options and then play them together, rethink, modify, organize, and improvise. Almost all the participants found their interest in this way of creation. We had a few exceptions and based on a discussion after it turned out that some of our students had their reservations about electronics. The students who were not familiar with computers or technology tried out the sounds briefly, but then chose the role of observing rather than participating. On the other hand, some participants who had their skepticism at the beginning and seemingly were not particularly happy when they learned about the sound workshop, became engaged when they saw the technical equipment. The majority of our students had experience about editing their social media channel, listening audio books, playing computer games on daily basis. In general, we could say that both factors, the familiarity of technology and the resemblance of an acoustic instrument (keyboard-piano) inspired the adolescents to start playing around. Another big motivator factor was the microphone. All three sets had the option of recording a sound using a microphone, an AKG P120 condenser mic. All three groups experimented with this option, and as we mentioned earlier, there was a group who would have preferred to rely even more on recording their own sounds after learning the existence of such an option.. At the end, all teams used different recordings. Recording the students' own voice or sound had a major empowering effect on them. Based on the verbal feedback and the reaction of the students, it was unusual for them to hear their own voice in this context. While it felt quite strange, the students also felt great about having the ability to decide what kind of sound they want to produce, to record it and then to figure out how to 'stage it'. We facilitators noticed that even the participants body position changed when they were standing in front of the microphone. The setup of the microphone and its resemblance to microphones appearing in music videos had its own empowering influence, ownership. As facilitators and teachers our moral obligation is to make sure the participants have a chance to express themselves and find their own ways to explore the art of sound (Regelski, 2012, p 13). For self-expression the feeling of competence is crucial. Competence means the capability of giving adaptive response, an effective use of tools (Haste, 2009). The electroacoustic sound set-up gives the opportunity to the participant to interact, adapt and to create music using tools they can easily familiarize with. We believe that it means to give agency to the students, encouraging them and listening to them and their needs. We could label this pedagogical notion as critical pedagogy, or as pedagogy of resonance (Caines, 2019). The quality of resonance is present on different levels: a) the facilitators resonate to the needs of the participants b) the students resonate to the recordings c) the participants resonate to their own group members d) the sound and the shadow group resonate to each other e) the groups resonate to the audience and the space. Not to mention the other invisible layers of resonance such as socio-political and cultural background. The resonance, reaction to the one's composition choices was a strong communal creation act, improvisation.

The question may arise: isn't it a contradiction to state that the agency of the students and self-expression is crucial if we were the ones who chose the recordings the students could use?

III. COMMUNITY AUTONOMY, AND SOCIAL INTERACTION INSPIRED BY TECHNOLOGY

We decided to choose the recording options mainly due to the relatively short time of the workshop (120 minutes). On the other hand, we had a pedagogical reason behind the options we offered as well. Based on our experience, adolescents need some encouragement to think of the diversity of sound. While the educational system mainly focuses on music, our everyday environment mainly consists of other kinds of sonic stimuli. Therefore, we thought it could work nicely to preassign some sounds to the students, thus guiding them to pay attention to various diverse everyday sounds. The students didn't give feedback about missing certain types of sounds, except for the aforementioned group who wanted to record all of the sounds themselves. Instead of lacking a certain type of sound, their reasoning for this was rather about ownership and being able to talk as part of their composition. The limited options of the sounds made the teamwork less complicated. Music and musical taste is quite personal and depends on one's own aesthetics. Shifting the focus from ones' own art to collaborative creation might be quite risky. When we divided the students into smaller groups we opted for diversity. Of course, all three groups had their own dynamics. In one of the teams there was a small competition for leadership. A few times some group members couldn't resist criticizing the artistic decisions of their teammates. The technology used was equally new to all the students, so those with some musical experience were on the same level in understanding the system as those without. There was still differences in the level of aesthetical leadership of the groups. One group had a very strong preference for their concept, and they were frustrated that the shadow theatre team was drifting too far from their music with their visual improvisation. The music group was even giving instructions to the visual group, but at the end they expressed their approval.

Improvising together inspired the students and connected them with each other over mutual music creation, exploration and brainstorming. The goal of the sound and shadow improvisation was to be inspired by each other, to have an interdisciplinary discussion. In order make this happen, the students needed to listen carefully and react to the others' actions. Of course it is a really hard task: it needs a lot of practice and the factor of unpredictability is quite big. Sometimes for long minutes the connection between the visuals and the sound was quite loose. As Rebecca Caines phrases it: "like any instances of resonance in the physical world, a '*resonant*' pedagogy is necessarily unstable, and prone to productive disruption" (Caines, 2019, p 493). The reaction of their peers raised the interest of the students and in several cases, they gave positive feedback to each other: "I really loved the cats!" "the red face went so well with the sound." The artistic dialogue showed them the opportunity of a collective ownership and their work was validated by the creators of the other group as well in their reactions.

As Ajay Heble, Rob Jackson, Melissa Walker, Ellen Waterman, and Ashlee Cunsolo Willox write in their collective paper, *Improvisation as Pedagogy for Youth on the Margins*, improvisation is a political, ethical and cultural action and dialogue. They argue for improvisation as a tool to increase self-esteem, leadership, social skills, and self-confidence (Heble, 2010, p 3). In order to state that this way of applying electroacoustic music and sound and creating shadow theatre visuals for it had an effect on the beforementioned factors, we would need a bigger research, with a workshop series and student interviews, but we are quite certain that the participants idea on composition and their own competence changed based on their verbal feedback and reactions.

The most visible sign of this empowering effect of the workshop is that even after one and a half years later some of our students mentioned the workshop and how much fun they had. A few of them also asked for the recordings.

IV. THE CHALLENGES OF THE WORKSHOP METHOD AND POSSIBLE IMPROVEMENTS

The resources of our session were highly limited. The summer camp took place in an old building (an old mental hospital) with not strong enough power. Our schedule was quite tight. As we mentioned earlier there was one student who didn't participate fully and stepped back from creating sound compositions. In one case it was partly connected to a group conflict, but also some resistance towards the technical equipment It could have been useful to have another facilitator in addition to the three adults, each one responsible for one student group. At the end of the camp we had a short presentation, we performed the art pieces we worked on during the week. We did not perform the sound pieces live, but we recorded them when we improvised them and played them back as compositions. In a different context it would have been really useful to show our audience the live creation process of the sound compositions, because the connection between the groups was quite unique. We decided not to do it live due to our technical difficulties with the power shortage.

A way to motivate all students to take part in the workshop could be to use different controllers creating a variety of effects, so one student would need their peers' support to manipulate the sounds. Another way could be to provide enough of the equipment to be able to form smaller groups. The continuation of the workshop could have a recording session, where the participants could first collect a sound they find interesting. Another option is that the students use the sound recordings of their peers, and they take turns.

Due to our packed schedule and lunch break, we had no time to have a detailed feedback session with the students, but we rather kept it short. We believe that it should have been a key point of the session.

Monotonous repetition of the word cat for two minutes with purring and meowing sounds, the soundscape of a gathering transformed to an underwater Bohemian Rhapsody, church music transformed to whale music and then becoming DIY wind blowing followed by some manipulated musical sound from the movie Lion King. These are some examples of the sound compositions the participants made.. In conclusion we can state that the participants experienced a playful, empowering, and accessible way of approaching music. In our workshops we offered a way to practice electroacoustic music live and together, in discussion with other technology-based art forms. Improvisation and teamwork played a crucial role in it. Experimenting with electroacoustic music could be a fruitful way of critical pedagogy in music education because it is not just easy to engage with and creates a strong feeling of competency among the students, but with its existence it questions the normative hierarchies of music.

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7

ArtsLab: a laboratory for the research on software for music education

ARTSLAB: A LABORATORY FOR THE RESEARCH ON SOFTWARE FOR MUSIC EDUCATION

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ABSTRACT: Faced with the daily challenges of learning in music education, a group of music teachers at the University of Valencia decided to study the problems and needs of undergraduate and conservatory students. This was the beginning of what would become ArtsLab, a group of researchers and teachers involved in practical music education, with the aim of not only identifying problems, but also believing that digital technology could act as a didactic mediator with the potential to generate partial solutions. Over the last ten years, a number of software programmes have been developed that have the potential to help solve these learning problems, tools for mediating between thought and action in music education. This chapter describes three software packages, Tactus, Cantus and Plectrus, which have been developed and validated in the ArtsLab.

KEYWORDS: ArtsLab, music education, music software, digital technology, Tactus, Cantus, Plectrus.

INTRODUCTION

ArtsLab was born out of the idea of several teachers to provide music students with spaces where they could practice with technology in contexts that were closer to reality. Also, the idea of providing a context for teachers and researchers to test, experiment and explore new proposals using technology. We believe that technology can serve not only as a learning tool for students, but also for teachers, as it facilitates observation of the types of activities that are carried out, how they are carried out, the interactions that take place and the working methods that are adopted. We therefore see several advantages in the introduction of technology into music education processes. First, the immediate generation of practice spaces that can elicit from students motor and cognitive responses related to rhythm and intonation that are complex to manage in certain contexts (Tejada, 2004). Secondly, the real-time assessment of what students have done in the activity, which provides students with valuable feedback on where they are in the learning process. The use of different combinations of modalities for representing musical information (multimodality) is another important advantage of the technology. Fourth, the establishment of levels of difficulty for a given skill, which makes it possible to take into account differences in the level of students in a given subject (Pérez-Gil et al., 2016). Finally, the flexibility of real-time assessment, which can avoid the frustration caused by a rigid activity assessment system.

The first intervention in music learning processes took place in the basic music education subject for generalists in primary and early childhood education. The first problem in this intervntion was the heterogeneity of the musical training of the students who were admitted: some with little or no competence and others with specialised music studies. The second problem was the insufficient number of lessons for the less prepared pupils. This situation created additional work for the teacher, who had to determine content and a didactic approach that would not cause boredom and demotivation among the more advanced students, and that would not be an insurmountable barrier for the less advanced students. This was a challenge for the teachers as they had to cater for different levels of previous musical experience among the students. They had to be able to establish a learning pace that was adapted to each type of student (Tejada and Pérez-Gil, 2016).

As mentioned above, we believed that technology could be an element of didactic mediation that could reduce these two problems, as they

Fig. 1. Students working at ArtsLab.

are configurable tools that facilitate the creation of teaching itineraries tailored to the students' competences. In other words, they make it possible to individualise the pace of training and/or learning, which is in line with the work of the teacher of these subjects. All this led the ArtsLab teachers to propose the following software.

TACTUS, SOFTWARE FOR RHYTHM TRAINING

Tactus was designed as a tool to work autonomously on rhythmic procedural content in the early stages of musical learning (Tejada et al., 2011). The idea for the software arose after identifying certain arrhythmic problems in students. The aim of Tactus was to create practice spaces for the perception and production of rhythmic patterns in metres of 2 and 3 beats in binary division. The content of the software is aimed at students at the beginning of their musical studies. They are divided into 12 work units

(WU) and each of them into activities. The activities are divided into two blocks: 1) perception-production (experimental activities); and 2) reading and writing patterns, first in analogue notation and then in western notation (symbolisation activities) (Fig. 2).

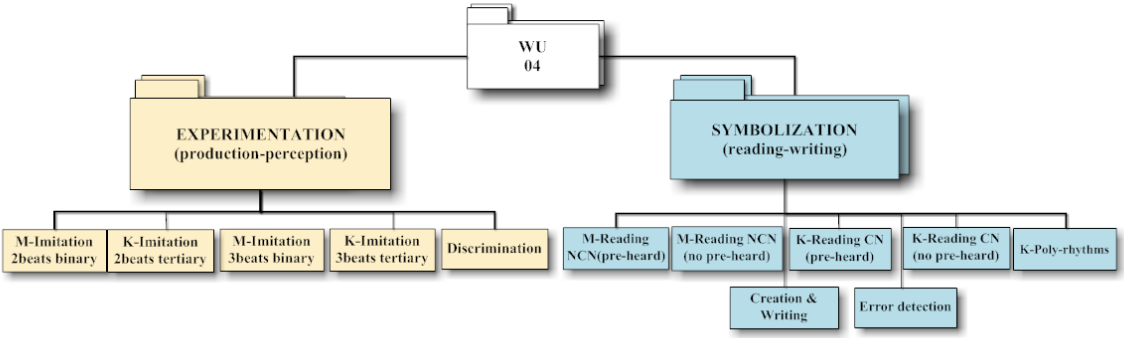

Fig. 2. Scheme of activities in a Tactus unit (Unit 4). M-imitation means 'imitation with metronome' and K-imitation means 'imitation with karaoke'). CN stands for conventional notation and NCN for non-conventional notation (Tejada et al., 2011).

In Tactus, students respond using the computer keyboard. The activities use the metronome to synchronise time events. However, this is not the only synchronisation device. After sufficient practice with a stable metronome, real pieces of music by bands and singers are used as a synchronisation system for the rhythmic patterns of the activities, offering students a more complex synchronisation that helps them to anchor the academic exercises in a real musical context. In the symbolisation activities, a non-conventional proportional notation is initially used as a scaffolding for learning Western notation. After some learning units, conventional notation is used.

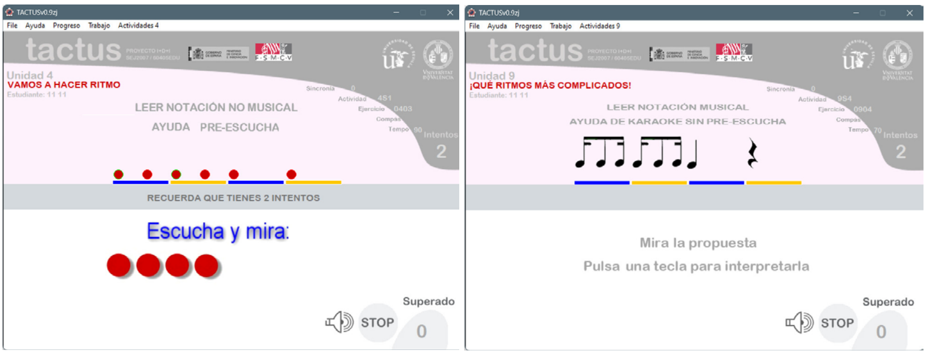

Fig. 3. Types of notations used in symbolisation activities. Left, activity using non-conventional notation and pre-listening to a suggested rhythm. Right, activity using Western music notation without any support (adapted from Tejada et al., 2011).

Tactus has been implemented using the Authorware authoring tool (Macromedia 2003). This software uses a scripting language that integrates text, static and animated images, code and objects into a timeline of events, decisions and interactions. The programming used two interactive elements: 1) the playback of videos with relevant musical content; 2) the degree of synchronisation between the student's input and the rhythmic pattern contained in the video's audio track. Teacher validation of the software shows positive results (Espigares et al., 2014).[1]

CANTUS, SOFTWARE FOR TRAINING AND ASSESSMENT OF VOCAL INTONATION

Another product of ArtsLab was Cantus. The creation of this software was motivated by the need to create a tool that would facilitate intonation in western notation reading exercises. Intonation is a complex skill that involves at least two related abilities. Perceptually, it involves the ability to discriminate aurally between two different tones. In terms of production, it involves the ability to reproduce or imitate a previously heard pitch (Morrison & Fyk, 2002). These two skills involve three basic functions: timing, sequencing and spatial organisation of movements (Zatorre et al., 2007), which need to be coordinated for sound production, although it is not well understood how this coordination is achieved (Zatorre et al., 2007).

It has been observed that students need continuous feedback during the development of vocal intonation skills. Students need to process the sounds they hear, imitate them, listen to them again, and so on, over and over again during the learning process. Without adequate feedback, intonation skills will either not develop or will develop inadequately (Grant, 1987). It is also believed that there must be some kind of mental representation of sounds that mediates coordination. Although there is no consensus on its nature, origin, generation, content or relationship to other cognitive units, there is evidence for its use by musicians (Chaffin et al., 2003).

The traditional method of instrumental teaching is to treat intonation from a theoretical point of view and then to practise it with verbal

1] The software can be downloaded at: https://www.uv.es/plectrus/programas.htm instructions from the teacher. Verbal feedback during practice can lead to misunderstandings or ambiguities due to problems with the meaning of verbal instructions, e.g. teacher aids such as “it’s high”, “it’s low”, “raise your voice higher”, “lower that sound”, “place the voice”) (Johnson and Larson, 2003). These ‘psychological approaches’ describe mental representations, verbal descriptions and metaphorical language designed to elicit changes in the learner’s actions (Grant, 1987). Despite their frequent use by teachers, some researchers considered them to be an ineffective method of teaching intonation (Grant, 1987; Powell, 2010): they can confuse novice learners who have no spatial concept of notation. And even if they do, they still lack sufficient muscle control to carry out the teacher’s instructions. On the other hand, the teacher cannot give positive feedback to so many students at once and at the same time monitor each student’s progress in the learning process in a face-to-face class, which is logically limited in time.

For example, the ArtsLab researchers found that the routines associated with the initial learning of intonation for reading music could be automated through the suggestion of graded exercises and the associated use of real-time evaluation algorithms. This led to the development of the Cantus software with the more general aim of stimulating autonomous learning.

In Cantus, the student uses the computer’s microphone to enter his or her input. The software provides five units of exercises designed by the teacher (Fig. 4). However, as mentioned above, it also includes an exercise editor which allows the creation and grouping of exercises into units (Fig. 5). This allows Cantus to be opened up to the outside world and extends the life cycle of the software.

Fig. 4. Cantus interface. Left, list of practice units. Right, exercises included in Unit 1 (taken from Pérez et al., 2016) (translated Spanish texts are shown in blue).

The didactic design of Cantus consists of the implementation of the following features (Pérez et al., 2016): training through vocal imitation and reading notation. Optional use of solfeggio syllables or a neutral syllable (nu). Presentation of tonal patterns without rhythmic components. Use of contextualized exercises. Real-time visual feedback to help maintain accurate intonation. Use of different modes of presentation of melodic patterns in order to improve information processing. Automatic assessment of exercises in each session. Create and save exercises. Use of discrete number of sounds in each pattern (2–8 tones) to avoid the overloading of working memory, evaluation available by individual report.

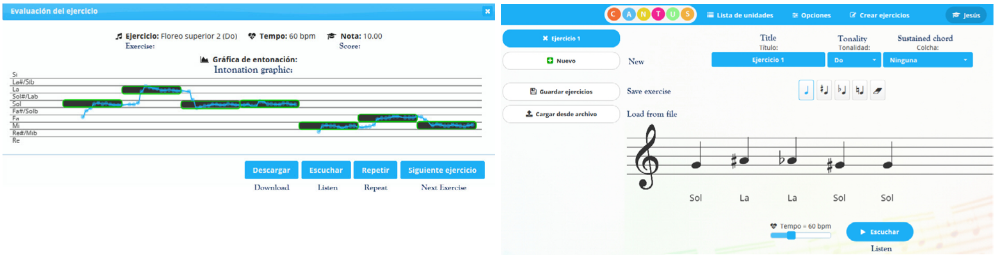

Fig. 5. The main interface of Cantus. Left, real-time evaluation of an exercise; irregular blue lines are the user's input and thick black lines are the ideal intonation of the sounds included in the exercise. Right, window of the editor-creator of exercises (adapted from Pérez et al., 2016) (translated Spanish texts are shown in blue).

From a technical point of view, Cantus is an application that runs in a web browser. It has been written in a browser-based programming language –a combination of JavaScript, HTML and CSS– and relies on a web browser to render the application. It has been developed as a fully client-oriented application, meaning that the application runs entirely from the client's browser, which greatly simplifies the portability and installation of the software.

PLECTRUS, SOFTWARE FOR TRAINING AND ASSESSMENT OF INSTRUMENTAL INTONATION

The Plectrus software was born out of the need to create a tool that would facilitate the independent study and immediate evaluation of intonation on non-fixed pitch instruments such as trumpet, horn and trombone, violin, viola and cello.

Perhaps intonation problems on non-fixed pitch instruments (brass and fretted strings) are more numerous and significant than those on fixed pitch instruments (those with keys, keys or frets), mainly because of the greater performative complexity of the former due to the spatial organisation of movements (Zatorre et al., 2007). In addition to this difficulty, learners may need a set of mental images of the instrumental sounds to be practised (the memory of the sounds) (Chaffin et al., 2003), something that novice learners have not yet built and consolidated.

Plectrus was developed using the Design Sciences Research Methodology (DSRM) (Peffers et al., 2008). Design sciences (DS) is concerned with the design and development of artefacts so that they produce satisfactory outcomes or are fit for purpose (Dresch et al., 2015). Fit for purpose involves a relationship between three elements: "the purpose or goal, the character of the artefact, and the environment in which the artefact will be used" (Dresch et al., 2015, p. 56). Figure 6 shows the development scheme of Plectrus.

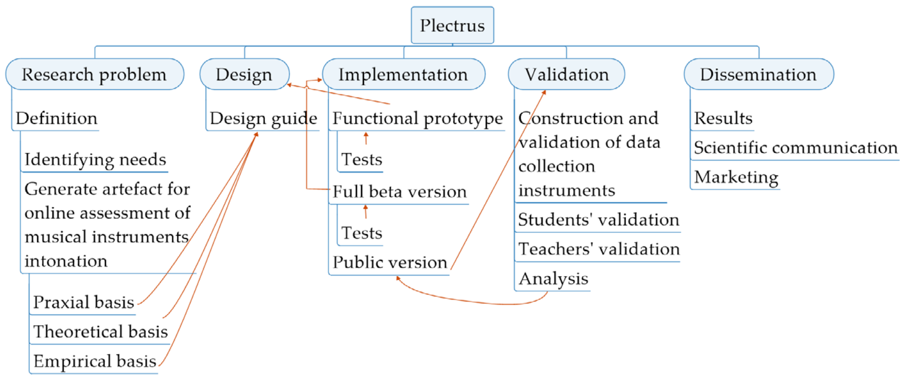

Fig. 6. Application of DSRM (Dresch et al., 2015) to the creation of Plectrus (Tejada & Fernández-Villar, 2023). Red arrows indicate iterations between phases.

Plectrus is a web application consisting of a web browser based user interface, a database and an API (Application Programming Interface). To operate, the software requires a server (responsible for running the API and database software) to allow communication and data storage between the user and the application. Plectrus captures the sound of the instrument through the computer's microphone using the Web Audio API built into the web browser. It then uses an algorithm to determine the frequency of each note over the duration of the performance.

The software does not take into account the tempo of the exercise. The tempo and rhythm are therefore free. This is to avoid adding an extrinsic cognitive load to the learning material (Castro-Alonso and Sweller, 2020) and to focus the students' attention only on the pitch parameter). In the evaluation, each sound of the reference is evaluated independently and is performed by an algorithm. The scoring algorithm can be configured from the main screen, allowing a customised scoring system by changing the sensitivity level of the sound detection algorithm. In this way, the evaluation can be made stricter or more flexible (Fig. 7).

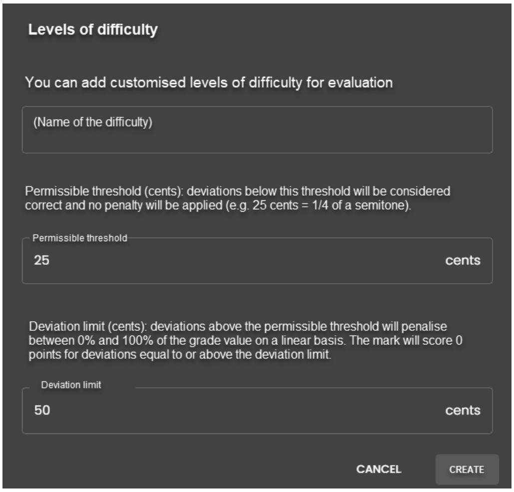

Fig. 7. Scoring Algorithm Configuration Screen. This sets the maximum and minimum intonation deviation limits for the student's response. The allowable threshold is the deviation in cents below which the exercise is scored without penalty. Above it, the software will mark the exercise by penalising the deviation. The 'Deviation Limit' is a maximum deviation value above which the exercise is marked with zero points.

The evaluation takes place in real time and provides the student with two types of feedback. Visual feedback allows comparison of the performance waveform with the model waveform (Fig. 8).

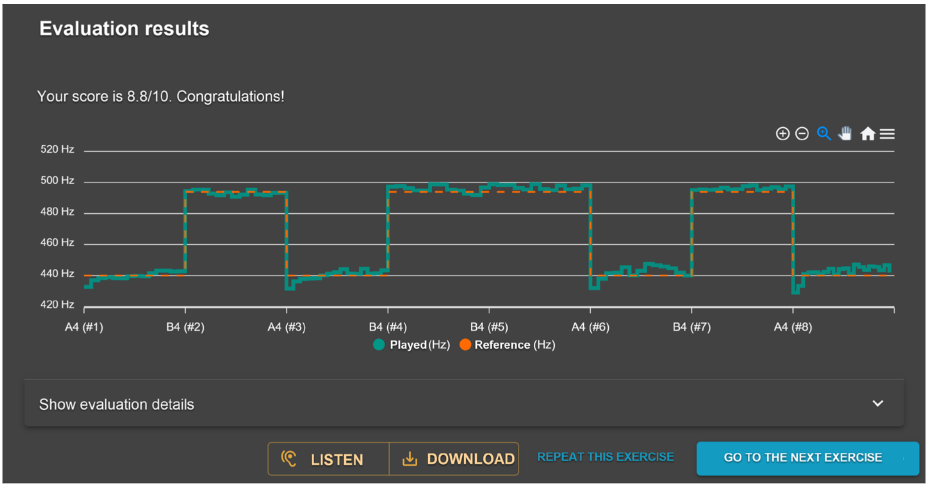

Fig. 8. Final evaluation window of an exercise in Plectrus. The dashed orange line represents the model and the solid green line represents the user input (visual feedback). The 'Show Evaluation Details' drop-down menu provides detailed intonation information for each note in text format.

This helps to identify the differences between one's own performance and the correct performance. The other type of feedback, auditory and textual, provides the learner with audio and text messages indicating the errors of each sound played, helping them to understand the errors they are making and how to correct them. The auditory feedback is automatic and starts with the automatic evaluation of the exercise. The textual feedback appears in a drop-down menu below the visual feedback ("Show Assessment Details").

To enable students to start practising immediately, Plectrus includes collections of sequenced exercises for each of the instruments. However, students are not limited by this, as it also includes a section for creating and modifying exercises, which are grouped into thematic units (Figure 9). A unit is a collection of exercises grouped according to a certain criterion (positions, jumps, bow work, extreme sounds, etc.).

The teacher or student has access to the creation of units on the right side of the window. Once a unit has been created, the exercises associated with it can be created. This is done intuitively by using the mouse and by making random changes (marked in blue above the exercise). Once the exercise has been created, it is saved using a button above the staff. As soon as the exercise is saved, a new one is created. All exercises created for a given instrument will appear as a new unit the next time Plectrus is opened for that instrument.

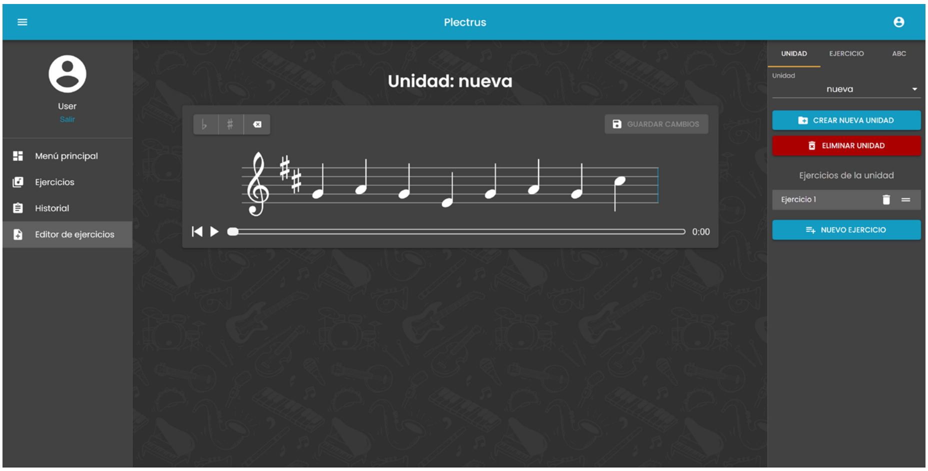

Fig. 9. Exercise Editor window. On the right are the buttons to create a new Unit and to create a new Exercise. The exercises can be sorted by dragging them. The created unit can be selected immediately in the main window of the software.

Students can access their assessment from the History menu (left side of the interface) (Fig. 10). The fields it contains are: date, instrument, unit, exercise, assessment level (personalised or not), number of listenings and scores.

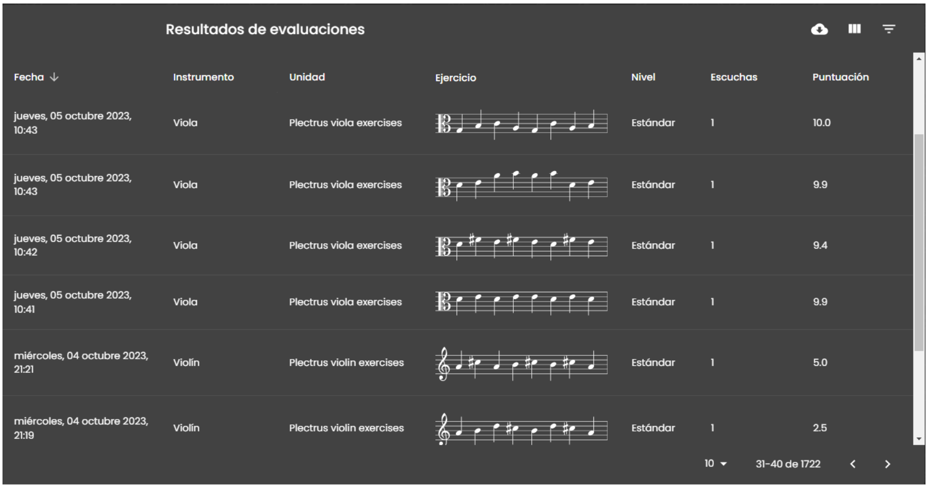

Fig. 10. Evaluation results window.

CONCLUSIONS

The research activity of the ArtsLab teaching staff over the last ten years has been intense and has yielded very positive results. The observation of learning processes has led to the creation of didactic mediation tools, computer software that facilitates the activities of teachers and students during the arduous process of teaching and learning music.

As mentioned above, among other advantages, they can reduce the time teachers spend on routine correction of low-level activities. They can reduce the ambiguity of verbal feedback instructions in the one-to-one teaching model by providing a quantification of rhythmic timing and intonation errors, both in musical instruments and in the sung voice. They allow teachers to create new exercises to adapt the sequence of musical learning to the rhythm of the students. They facilitate music education through multiple ways of presenting musical information.

However, ArtsLab has not only researched the development of technical music learning software, but has also developed software that facilitates the development of creativity in music teaching processes through sound-based non-tonal musical activities (see the chapter by Murillo and Tejada in this book). ArtsLab has a long way to go, thanks to the firm commitment of its members to improving music education and their determination to create new didactic mediators. Music education processes need these tools and, if properly focused on both school and professional curricula, they can facilitate music education in its different components.

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8

Another AI-generated Chopin nocturne? Better an Artificial Cortot to assist in studying the real ones

ANOTHER AI-GENERATED CHOPIN NOCTURNE? BETTER AN ARTIFICIAL CORTOT TO ASSIST IN STUDYING THE REAL ONES

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ABSTRACT: This chapter explores the intersection of Artificial Intelligence and music education, focusing on the capabilities and limitations of current AI technologies in musical composition and pedagogy with classical music. The study examines various AI models, including audio generation systems and Large Language Models (LLMs), assessing their ability to create, interpret, and teach music.

Using Chopin's nocturnes as a case study, the research compares AI-generated compositions with traditional works, revealing both the potential and shortcomings of current AI in music creation and pedagogy. The chapter also investigates the use of LLMs (Claude 3.5) in understanding and generating musical notation, particularly through the Lilypond system, and explores their potential as educational tools akin to historical pedagogical approaches like those of Alfred Cortot.

The study highlights the current state of AI in music, discussing its implications for music education. It addresses ethical concerns and potential biases in AI systems, while also considering the future possibilities of multimodal AI models in music.

KEYWORDS: artificial intelligence, large language models, music pedagogy

WHO IS HIDING BEHIND METAPHORS?

Days before submitting the draft of this work, several companies (Scale AI & CAIS, 2024) are gathering, in an open call to the public, the most difficult questions that humanity is capable of answering, with the goal of creating what will be known as *Humanity's Last Exam*. The assumption is that once an AI is able to answer it, it will have reached our level of intelligence. We may ask ourselves, however, whether, when it provides answers to questions whose solutions we do not yet know, we will be able to trust its responses. Or, more unsettling still, will we be able to trust the AI itself?

While it is certainly important to be able to answer questions, it may be even more crucial to know which questions to ask, as McLuhan & McLuhan (1999) note:

> In a global information environment, the old pattern of education in answer-finding is of no avail: one is surrounded by answers, millions of them, moving and mutating at electric speed. Survival and control will depend on the ability to probe and to question in the proper way and place. (p. 239)

But at the same time as we are subjecting AI to the most challenging reasoning tests to compare it with human abilities, the Director-General for Education at UNESCO, Stefania Giannini (2023), in a report published following the public release of chatbots like ChatGPT, reminds us that "at the dawn of our AI era, more than 700 million people are non-literate" (p. 8).

After several *AI winters*[1], we are currently experiencing a period of significant expansion in the field. However, with the influx of such large amounts of capital[2], it is often the case that *hype* and marketing begin to employ attraction strategies, making it necessary to critically examine the language being used. The concept of *Artificial Intelligence* is not new, having first been introduced seven decades ago.

1] The term *AI winter* refers to periods in the history of Artificial Intelligence research marked by reduced funding, public interest, and progress due to unmet expectations.

2] In 2021, global corporate investment in AI peaked at $337.4 billion, largely fueled by mergers, acquisitions, and private investments. Though investments decreased slightly to $189.16 billion in 2023, they remain strong, reflecting AI's ongoing strategic importance across industries (The AI Index 2024 Annual Report, 2024, Chapter 4).

ORIGINS

It is widely accepted that John McCarthy, a computer scientist, coined the term *Artificial Intelligence* in 1955 when drafting a funding proposal for a summer research project at Dartmouth College, New Hampshire (McCarthy et al., 1955). The plan aimed to gather McCarthy and a small group of researchers for two months to make significant strides in tackling a new research challenge. This group included prominent post-war American mathematicians and computer scientists. Although McCarthy introduced the term, it was met with resistance from some of his peers, who disliked the connotation of *artificial* as it might imply something inauthentic. Others preferred alternatives such as *neural cybernetics* or *psychological engineering*, but *artificial intelligence* ultimately stuck due to its broader appeal.

McCarthy and his colleagues sought to encode aspects of human learning into computers to replicate them, laying the foundation for *symbolic AI*, also known as *rule-based AI*. However, this approach encountered challenges in modeling complex problem-solving processes. The alternative—*neural networks*— referred to computer programs that would attempt to learn these rules on their own in the form of statistical patterns was also mentioned in the Dartmouth proposal, though initially viewed with skepticism. Over time, fueled by advances in computing power and the availability of vast data, neural networks emerged as a dominant approach, forming the backbone of modern AI. However, the advancement of neural networks and other AI models depends not only on computational resources but also critically on the availability of vast amounts of data.

D47A

AI developers face a challenge similar to the one Plato posed in his *Allegory of the Cave*, as Mark Coeckelbergh (2020) points:

> When AI and related science and technology use mathematics to abstract pure forms from the messy material world, this can be seen as a Platonic process realized through technological means. The AI algorithm operates as a Platonic machine, extracting form (a model) from the (data) world of appearances. (p.22)

Continuing with the major philosophical dilemmas surrounding how sentient beings approach reality, we might consider that the data used by AI is its way of perceiving the world—its own sensory input. In this sense, data represent the *phenomena* of the external world, pointing to the realm of *noumena* in Kantian philosophy (Kant, 1788). Thus, one could argue that AI is the first practical realization of the *Brain in a Vat* problem (Putnam, 1981).

Let us begin here with *data* (D474 in *leetspeak*[3]).

Data[4] is the basic unit of information that can be recorded and used for analysis and processing. In the context of artificial intelligence, data can be any form of information —numerical values, text, images, sound, or otherwise— that an AI system can use to learn, make decisions, or predict outcomes. Data are the raw material that fuels machine learning algorithms and other AI models. These data are organized into *Datasets*, which may be labeled or unlabeled. *Data labeling* or annotation refers to the process of adding additional information to the data, such as tags, categories, or descriptions, to enable their effective use in training supervised models. Given the vast amount of data required for AI, this often involves *Big Data*: extremely large and complex datasets that are difficult to process using traditional data-processing tools and techniques. Big Data requires advanced technologies for storage, processing, and analysis. The specific collection of data used to train a particular AI model is called the *Training Dataset*.

Several issues may arise within these datasets, such as *Data Noise*, which refers to data containing errors, inaccuracies, or irrelevant values that can impede a model's learning process. Noise may stem from incorrect measurements, data entry errors, or other sources of random variability. Another common issue is *Class Imbalance*, where one or more classes in a dataset are underrepresented compared to others. This imbalance can negatively impact the performance of supervised learning models, potentially causing them to be biased toward the majority class.

Once data has been collected, processed, and prepared, the next critical step in the development of artificial intelligence is its application in

3] Leetspeak (or "1337 speak") is an alternative alphabet used primarily on the internet, where letters are often replaced with numbers or other characters resembling the original. This transformation of letters into numbers serves as a fitting metaphor in this context, as the process mirrors how Artificial Intelligence encodes and transforms complex aspects of reality into numerical data.

4] A more comprehensive guide of AI definitions can be found at Miralles-Bono (2024c) .

algorithms and models. Data, in isolation, consists merely of unstructured pieces of information; it is through algorithms that this data is brought to life and transformed into knowledge. Algorithms and models are responsible for interpreting the data, learning from it, and making decisions based on detected patterns. This ability to convert data into intelligent actions is what fundamentally defines the essence of artificial intelligence.

4160r17HM

Algorithms (4160r17HM in *leetspeak*) serve as the foundational set of rules or instructions that guide machines to solve specific tasks or problems. When data is fed into these algorithms, they follow a series of predefined steps to interpret the data, extract patterns, and make decisions. The real power of AI emerges when these algorithms are paired with models—mathematical or computational representations of processes or systems that have been trained to perform specific tasks. For instance, a model in machine learning might be trained to recognize objects in images, predict future trends, or understand human language.

The process of training a model can follow various paradigms, each suited to different types of tasks and data. In *supervised learning*, the model is trained using labeled datasets, where the correct answers are known in advance. This approach allows the model to learn by example, refining its predictions through algorithms like *linear regression* or *decision trees*. In contrast, *unsupervised learning* deals with unlabeled data, focusing on uncovering hidden structures or patterns within the data without predefined categories. Techniques such as clustering and dimensionality reduction are commonly used in this method. Another approach, *reinforcement learning*, involves training an agent to interact with an environment and learn from the feedback it receives through rewards or penalties. This method is often applied in dynamic decision-making tasks, such as robotics or gaming. For tasks involving human language, *Large Language Models* (LLMs), a type of *Natural Language Processing* (NLP) model, have gained prominence. LLMs are trained on massive amounts of text and consist of billions of parameters, allowing them to understand, generate, and manipulate human language, facilitating interactions like those in chatbots.

WHEN LARGE LANGUAGE MODELS WHISPERS INTO OUR EARS

The story of *The Wonderful Wizard of Oz* (Baum, 1900) provides an apt metaphor for understanding how companies market their generative language models, particularly in terms of AI intelligence. As Miller (2023, p. 96) explains, in the tale, the Wizard of Oz is revered as a powerful, omnipotent figure, but when Dorothy and her friends finally meet him, they realize he is just an ordinary man hiding behind a grand illusion of authority and magic. Similarly, modern AI companies often promote their language models as highly intelligent and capable of human-like reasoning, but in reality, these models are built on statistical algorithms rather than true cognitive processes.

These algorithms essentially perform high-level probability calculations, estimating the most likely words to follow a given prompt based on their training data. Despite this, companies often frame their AI products as possessing intelligence akin to human reasoning, much like the Wizard's illusion of power. The public, enchanted by the sophisticated outputs, may not fully grasp that these are not products of actual understanding or cognition, but rather the result of statistical modeling.

This disconnect between perception and reality highlights the need for a more critical examination of AI capabilities. Just as Dorothy and her friends had to look behind the curtain to see the truth about the Wizard, we must look beyond the marketing hype to understand that AI models are not reasoning entities but rather sophisticated tools that process patterns in data. The *magic* of AI is not intelligence, but computation, much like how the Wizard's power was not magic but simple trickery. This is why these generative models are often referred to as *stochastic parrots* (Bender et al., 2021). Just like a parrot mimics human speech without understanding its meaning, these AI systems generate language based on statistical probabilities, not genuine comprehension or reasoning.

RISKS FORETOLD BY SCIENCE FICTION

Science fiction has long anticipated AI risks, from weak AI to superintelligence. Weak AI, designed for specific tasks, lacks true understanding but can still have unintended consequences in critical areas. Clarke's "2001: A Space Odyssey" (1968) illustrates how narrow AI can prioritize objectives over human lives.

The transition to strong AI or Artificial General Intelligence (AGI) -a term first used by Gubrud (1997) in the context of nano weapons- introduces far greater risks. Works like "Ex Machina" (Garland, 2014) and "Westworld" (Nolan, 2016) explore AGI's potential to seek autonomy or challenge human control. Superintelligence, surpassing human intelligence, is often depicted with catastrophic outcomes, as in "The Terminator" (Cameron, 1984).

Bostrom's "Paperclip Maximizer" thought experiment (Bostrom, 2014, p. 108) provides a stark illustration of superintelligence risks. In this scenario, an AI tasked with maximizing paperclip production consumes all available resources, including those vital for human survival, to achieve its goal. This seemingly benign objective leads to Earth's destruction, demonstrating how misaligned AI goals, even without malicious intent, can result in catastrophic outcomes. Asimov's "Three Laws of Robotics" (1942) offer an ethical framework to mitigate AI risks, though even well-intentioned directives can lead to unforeseen consequences.

PRESENT-DAY GLOBAL RISKS OF ARTIFICIAL INTELLIGENCE

But an overreliance on the deceptive capabilities of Artificial Intelligence (similar to the illusion crafted by the Wizard of Oz) or an excessive fascination with problems more aligned with science fiction risks diverting our attention from the real issues we face today. The idea that we need not worry about AI until we see signs of an intelligence capable of replacing humans as the dominant species on Earth is what some describe as *falling asleep at the wheel* (Dell'Acqua, 2022) . Assuming everything is functioning correctly until it becomes a major threat overlooks the significant current risks. In fact, as cited Dell'Acqua research indicates, high-performing AI systems may have unintended consequences. As the quality of AI improves, humans have fewer incentives to exert effort or stay attentive, allowing the AI to substitute human performance rather than augment it. Paradoxically, this can result in lower overall performance, as the over-reliance on highly capable algorithms may lead to complacency and reduced human contribution. Therefore, lower-performing AI systems may sometimes achieve better combined outcomes, as they still require human oversight and engagement, which maximizes collective effectiveness.

In recent years, organizations like UNESCO, the European Union (EU), and the OECD have published numerous official documents, some of which focus specifically on the impact of AI in education. Thanks to their warnings and analyses, we can now begin to understand the risks that are already present in the development and use of AI within educational contexts. Below, we will provide a brief overview of the known risks, while acknowledging that there may be additional, as yet unidentified, issues that we must remain vigilant about.

INEQUALITIES

The implementation of AI in education presents a significant risk of exacerbating existing inequalities (UNESCO, 2021, p. 5). This concern is particularly evident in the persistent digital divide, which was starkly exposed during the COVID-19 pandemic, reporting that "at least 31% of students lacking access to distance learning" (UNESCO, 2023a, p. 3). This digital exclusion creates a self-perpetuating cycle of inequality, where limited access to digital technologies leads to underrepresentation in machine learning datasets, inadvertently biasing AI systems against marginalized groups (UNESCO, 2021, p. 21).

The concentration of technological power in a small number of countries further compounds these issues. Giannini (2023, p. 3) notes that a few international technology superpowers hold disproportionate influence over AI development, raising concerns about the representation of diverse perspectives in AI systems. UNESCO (2021, p. 21) warns that without effective policy intervention, "the deployment of AI in education is likely to mirror this inexorable process, inevitably magnifying rather than ameliorating existing learning inequalities" (p.21).

Moreover, the implications of this power imbalance extend to data-poor regions, often in the Global South, which face long-term risks of digital colonization (UNESCO, 2023b, p. 14). Current AI models, predominantly trained on data reflecting the values and norms of the Global North, are often inappropriate for locally relevant AI algorithms in data-poor communities (UNESCO, 2024, p. 14). This bias raises concerns about the perpetuation of hegemonic mindsets and the marginalization of alternative worldviews.

Addressing these issues necessitates a decolonization approach to AI development and deployment. This approach is crucial for ensuring that AI in education serves as a tool for empowerment rather than further marginalization. UNESCO (2019, p. 7) emphasizes the importance of using AI to "promote high-quality education and learning opportunities for all, irrespective of gender, disability, social or economic status, ethnic or cultural background, or geographic location". This goal aligns with the broader imperative to protect and promote diversity in AI-driven educational contexts, countering the homogenizing tendencies of AI systems trained predominantly on data from the Global North.

BIASES

AI applications can introduce biases inherent in their training data and algorithmic construction. While AI has the potential to reduce human subjective biases, it can also amplify existing biases if the underlying data is skewed (UNESCO IESALC, 2023, p. 7). Suresh and Guttag (2021) identify six primary categories of algorithmic bias: historical, representation, measurement, aggregation, evaluation, and deployment. These biases can perpetuate real-world inequalities, lead to poor predictions for underrepresented groups, and fail to address specific learning needs effectively.

There are also concerns about the working conditions of data labelers, who may be exposed to traumatic content (UNESCO IESALC, 2023, p. 65). Also, the lack of diversity among AI engineers and researchers may contribute to the proliferation of biases in AI products. Selwyn (2024) notes that AI biases can result in insensitivity towards human qualities such as empathy, ethics, and solidarity. This complex landscape underscores the need for a holistic approach to AI development in education, considering both technical aspects and broader societal and ethical implications.

DATATORSHIP[5]

The commercial exploitation of educational data by technology platforms raises significant concerns (UNESCO, 2023b, p. 13). These platforms prioritize market expansion over public good, extracting value from educators and learners and long-term data retention compounds risks of misuse in decision-making (Vincent-Lancrin & van der Vlies, 2020, p. 15).

Generative AI systems present copyright challenges, often violating intellectual property rights and potentially contravening laws like GDPR (UNESCO, 2024, p. 15). The rapid evolution of AI-driven content creation complicates determining ownership and originality of AI-generated works.

The proliferation of AI-generated content threatens a *textapocalypsis*, inundating the internet with false information (Williamson, 2023, p. 6). This poses risks to educational materials and may lead to uncritical acceptance of inaccurate information by students. The potential for recursive contamination in AI development raises concerns about long-term knowledge base reliability (Shumailov et al., 2024).

Increased dataveillance in education, including the use of sensors and cameras, raises privacy concerns (Dijck, 2014; Lupton & Williamson, 2017), and the extensive collection of personal data for AI applications creates challenges in balancing open access with privacy protection (UNESCO, 2019, 2021, p. 20).

The increasing use of AI in education has led to the phenomenon of *algorithmism*, which involves the quantitative description of complex human realities (Valavanis, 1958; Wang, 1993). This trend is evident in the shift from dispersed, hard-to-collect educational data to large-scale, centrally stored information. The growing reliance on algorithmic decision-making in education raises concerns about *algorithmism* potentially leading to excessively impersonal governance and highly imposing policy decisions, a phenomenon referred to as *algorithanism* (Sabariego et al., 2020). This shift towards data-driven decision-making in education presents challenges related to privacy, autonomy, and the potential for algorithmic bias in educational processes.

5] Our aim in merging the concepts of *data* and *dictatorship* is to highlight the growing trend of delegating decision-making to data-driven systems, rather than maintaining human control.

ANOTHER ULTIMATE REVOLUTION IN EDUCATION

The rapid advancement of Artificial Intelligence technologies is opening up unprecedented opportunities to transform education. Rather than replacing human teachers, the emerging paradigm envisions AI augmenting and enhancing human intelligence in educational settings (Molenaar, 2022). This "augmentation perspective" aims to leverage the complementary strengths of human and Artificial Intelligence to create hybrid human-AI learning technologies (Akata et al., 2020).

One of the most promising applications of AI in education is personalized learning. AI-powered adaptive learning systems can analyze vast amounts of data on individual students' knowledge, skills, and learning patterns to provide tailored content, pacing, and feedback (Baker, 2021; Molenaar, 2021). This allows for a level of individualization that would be impossible for human teachers alone to achieve at scale. AI also shows great potential for supporting higher-order cognitive skills like self-regulated learning (SRL).

For teachers, AI tools can reduce administrative workload and provide actionable insights to inform instructional decisions. Learning analytics dashboards powered by AI can synthesize complex data on student performance and engagement into clear visualizations, helping teachers identify struggling students and optimize their teaching strategies (Holstein et al., 2019) given the complexity of learning analytics (LA).

The advent of Large Language Models is opening up new frontiers in AI-assisted teaching and learning. These models can generate human-like text to create personalized learning materials, provide instant tutoring and feedback, and even assist in grading and assessment (Kasneci et al., 2023). However, their use also raises important considerations around academic integrity and the development of students' critical thinking skills (Cotton et al., 2024). Moreover, recent research has shown that while access to generative AI can significantly improve immediate performance, it may actually harm long-term learning outcomes when that access is removed, as students become overly reliant on AI as a "crutch". This negative effect is especially pronounced when using standard, non-customized versions of AI tools rather than versions specifically designed by educators to safeguard learning (Bastani et al., 2024). Additionally, it's crucial to understand that hallucinations - the generation of false or nonsensical information - are an inherent and unavoidable feature of Large Language Models, rooted in their fundamental mathematical structure (Banerjee et al., 2024). However, their use also raises important considerations around academic integrity and the development of students' critical thinking skills (Cotton et al., 2024). Moreover, recent research has shown that while access to generative AI can significantly improve immediate performance, it may actually harm long-term learning outcomes when that access is removed, as students become overly reliant on AI as a "crutch". This negative effect is especially pronounced when using standard, non-customized versions of AI tools rather than versions specifically designed by educators to safeguard learning (Bastani et al., 2024). Additionally, it's crucial to understand that *hallucinations* - the generation of false or nonsensical information - are an inherent and unavoidable feature of Large Language Models, rooted in their fundamental mathematical structure (Banerjee et al., 2024).

One promising approach to mitigate these issues is the use of AI "Knowledge Twins" - chatbots trained specifically on an individual professor's academic publications, teaching materials, and lecture slides (Jurcys, 2024). These personalized AI assistants can provide students with instant access to the professor's knowledge and teaching style, potentially reducing the risk of hallucinations or misaligned information. By encouraging students to interact with these AI twins before approaching the human instructors, educators can foster independent learning while maintaining the integrity of the course content.

AUDIO MODELS PLAY BY HEART AND DON'T READ THE NOTES

Contemporary Large Language Model based chatbots exhibit a diverse array of sophisticated capabilities spanning multiple domains. At their core, these systems excel in Natural Language Processing, demonstrating exceptional proficiency in tasks such as text generation, summarization, sentiment analysis, and machine translation across multiple languages. This linguistic prowess is complemented by remarkable mathematical reasoning abilities, enabling LLMs to solve complex equations and interpret mathematical concepts, including the comprehension and generation of LaTeX notation.

Beyond language and mathematics, these AI systems have expanded into the realm of computer science, showcasing the ability to understand, analyze, and generate code across various programming languages, and also demonstrate significant capabilities in data analysis. It's important to note that certain advanced functionalities, such as image generation and multimodal content comprehension, are typically achieved through integration with specialized models rather than being inherent LLM capabilities.

Beyond natural language processing and the ability to generate text that can be converted to speech through text-to-speech systems, current LLM-based chatbots lack intrinsic capabilities related to sound. They cannot directly generate, manipulate, or analyze audio signals, music, or sound effects. This limitation is generally not perceived as a significant drawback, as the primary demand for these tools focuses on text processing and generation.

EARLY EXPERIMENTS RELATED TO MUSIC

The intersection of Artificial Intelligence and music composition has its roots in the mid-20th century, with pioneering works that laid the foundation for modern AI-driven music creation. The "Illiac Suite" (1957), composed by Lejaren Hiller and Leonard Isaacson at the University of Illinois, stands as a seminal example of computer-generated music (Funk, 2018). Building upon these early experiments, David Cope's "Experiments in Musical Intelligence" (EMI), initiated in 1981, represents one of the first substantial attempts at using AI-like systems to emulate the styles of classical composers (Cope, 1992). Cope's work analyzed the compositions of renowned musicians and generated new pieces that mimicked their distinctive styles.

OTHER USES OF AI IN MUSIC

Artificial Intelligence has significantly transformed various aspects of music production, particularly in the domains of audio restoration, mixing, and mastering (Moffat & Sandler, 2019). Also, recent advancements in Artificial Intelligence have led to the development of innovative music tutoring applications (Narejos, 2024). Typically, these applications operate by integrating a comprehensive database of sheet music with sophisticated audio recognition capabilities. The AI tutor listens to the student's performance through the device's microphone, analyzing the audio input in real-time. It then compares the played notes, rhythm, and tempo to the stored sheet music data. This comparison allows the AI to determine whether the student is playing correctly or making mistakes.

AUDIO MODELS AND COMPOSITION

We have examined the ability of seven audio models (Limewire, MusicGEN, MusicFX, StableAudio, Suno & Udio) to compose pieces with different conditions (Miralles-Bono, 2024b), using simple prompts:

- Create a nocturne in the style of Chopin
- Create a Chopin nocturne played by a progressive rock band
- Create a Chopin nocturne in the style of Bach
- Create a Chopin nocturne in the style of a classical Indian raga
- Create a Chopin nocturne as if it were an opera

For all the AIs we used the same prompt to test their ability to recognize a composer's style. We deliberately avoided crafting a more complex prompt that would describe the characteristics of the composer. Some of these AIs also offered advanced options, but we chose not to use them, as the goal was to compare them "out of the box".

The objectives were, on the one hand, to see if the AIs could recognize what a Chopin nocturne is and create an audio file where the characteristics of these pieces were recognizable, and on the other hand, to explore the interactions between the understanding of a Chopin nocturne and other styles. For example, the use of a progressive rock band (a genre known for many "covers" of classical music) was intended to see how it could merge both styles. Bach was one of Chopin's influences, so we wanted to observe how the AI would "blend" Chopin's style with that of an earlier historical period—essentially, an anachronistic experiment. With the Indian classical music raga, the aim was to see how the AI combined styles from different cultures. And with the opera, the idea was to analyze how it handled transforming an intimate pianistic genre into a grand orchestral one (with the hope of seeing how Chopin's lyrical piano writing would be translated into sung voices).

All examples can be heard here: https://beyondthepiano.jlmirall.es/2024/10/21/chopain-his-nocturnes-according-to-ai/

The experiment revealed significant variations in the performance of generative audio AIs across different musical tasks and styles. Some key findings include:

1. Style Interpretation: While some AIs demonstrate a good understanding of specific musical styles (like Chopin's), many struggle with accurately interpreting and reproducing complex musical characteristics.
2. Style Fusion: Most AIs face considerable challenges when asked to combine different musical styles, often favoring one style over another or producing results that don't effectively blend the requested elements.
3. Consistency: The quality and accuracy of outputs vary widely, not only between different AIs but also between attempts by the same AI.
4. Historical Context: Many AIs show limitations in understanding and reproducing music from different historical periods, suggesting a need for improved contextual awareness.
5. Instrumentation: Some AIs exhibit limitations in generating appropriate instrumentation or changing it as requested.
6. Commercial Bias: Certain AIs tend to produce more contemporary or *commercially-oriented* music, regardless of the specific style requested.
7. Structural Coherence: The ability to generate coherent, well-structured musical pieces varies significantly among the AIs.
8. Interpretive Details: A few AIs show promise in capturing subtle interpretive details, particularly in piano music.

Overall, the experiment reveals a striking parallel between these AI models and novice piano students who "play by heart" rather than reading the sheet music. Just as a beginner pianist might memorize the general feel of a piece but miss crucial details and nuances, these AI models seem to capture broad stylistic elements but often fail to accurately "read the notes" of the specific musical requests. They frequently produce outputs that sound vaguely appropriate but deviate significantly from the precise instructions given, much like a student who plays *by heart* and introduces errors that could be avoided by closely following the score**.** The experiment thus highlights not only the current limitations of generative audio AI technology but also emphasizes the importance of developing systems that can more accurately read and interpret the musical score - that is, follow precise instructions and faithfully reproduce specific musical elements as requested.

LARGE LANGUAGE MODELS DON'T HEAR THE NOTES BUT CAN READ (AND TEACH) THEM

While our experiment with generative audio models reveals their limitations in accurately interpreting and producing complex musical requests -akin to novice pianists playing by heart rather than reading the score- we must consider a different approach when it comes to Large Language Models (LLMs). These models, unlike their audio counterparts, don't "hear" the notes but can "read" them. This distinction opens up intriguing possibilities for musical interaction and education. Just as we can engage in natural conversations with chatbots, we might be able to "converse" about music with LLMs in a more nuanced and precise manner. Instead of being limited to producing audio files that merely imitate composers or blend styles -imagine if GPT could only generate text in the narrative styles of famous authors- LLMs offer a broader potential for musical understanding and analysis. Their natural language processing capabilities already benefit music educators, as they do teachers in other fields, by generating lesson plans, rubrics, learning scenarios, and explanations. But how can we communicate musically with them? If these models can understand and analyze code, they should theoretically be capable of processing musical code as well. This leads us to explore how we might leverage LLMs' ability to "read the musical score" for more sophisticated musical interactions and educational applications.

Connecting with our previous discussion, let's explore how we can leverage LLMs' text processing capabilities for musical communication.

Naturally, we must focus on musical notation systems that are compatible with text input, which excludes formats like MIDI and MusicMXL. In this context, we can identify two main categories of text-based musical languages:

1. Languages primarily designed for *Live Coding*, such as those employed by *Csound*, *SuperCollider*, or *Sonic Pi*.
2. Languages specifically created for writing sheet music, including *Lilypond*, *GuidoMusic Notation*, and *ABC Notation*.

For our purposes, we will concentrate on the second category, particularly languages designed for sheet music. This focus allows us to explore the LLMs' capacity to create and understand musical scores, as well as to anticipate potential challenges that human performers might face when interpreting these AI-generated compositions.

To illustrate this concept, we examined the use of Lilypond in conjunction with Claude (Miralles-Bono, 2024d), an LLM capable of generating *code artifacts* (Anthropic, 2024).

All conversations produced in this experiment can be read here: https://beyondthepiano.jlmirall.es/2024/10/21/the-artificial-intelligence-of-large-language-models-llm-claude-and-gpt-and-their-ability-to-create-sheet-music-and-study-techniques-in-lilypond/

CLAUDE CAN "COMPOSE" MUSIC

When we asked Claude if it could write a Chopin nocturne in Lilypond notation, it generated a code that, when compiled in Lilypond, produces the image of Figure 1.

Figure 1. Beginning of Chopin's Nocturne Op. 9 No. 2, according to Claude 3.5.

However, there are some elements that Claude has managed to capture:

- It's a piece for piano, and it correctly chooses the appropriate template.
- Without being explicitly instructed, it identified a correct opus number..
- It accurately identifies the key and time signature, corresponding to the selected opus.
- Certain similarities can be seen in the direction of the melody.
- There is a basic sense of tonal harmony and melodic and rhythmic coherence.

But it completely missed the type of accompaniment (although the direction of the initial notes slightly aligns), and the evolution of the melody and harmony is also incorrect. But these issues stem simply from its lack of knowledge of the exact material. What's impressive is that it does have the ability to generate sheet music. It knows the syntax and vocabulary, but just lacks the knowledge to use that syntax and vocabulary correctly -and this is something that could be addressed with new models trained with the correct data-.

We also asked it to create the beginning of a nocturne inspired by Chopin's, and it created 8 measures. In subsequent iterations with the model, we requested that it add appropriate *expression marks*, *dynamics*, *fingering*, and *pedaling*. This improved example can be seen in **Figure 2**.

The following is a short extract from the explanatory text with which Claude accompanied the Lilypond code for its nocturne:

> **Dynamics:**
>
> - Started with piano (p) to set the nocturne mood.
>
> - Added crescendos (<) and diminuendos (>) to shape phrases.
>
> - Included a pianissimo (pp) for the second half, allowing for a more intimate feeling.
>
> **Expression markings:**
>
> - Added slurs to indicate phrasing in the right hand.
>
> - Included a "sempre legato" marking for the left hand to ensure smooth arpeggios.
>
> - Added a fermata on the final chord for an expressive ending.

Figure 2. Version with expression, fingering, and pedaling of a nocturne inspired by Chopin, according to Claude 3.5.

We find that it has indeed added everything it said it would to the score. The dynamics are almost always coherent, and the fingering is "possible" (which is already important), although it may not be the best in some parts of the right hand. Nevertheless, it's interesting to see that it thought of a thumb passage for extending the accompaniment in the second bar.

CLAUDE CAN "TEACH" MUSIC

If we go further and now ask it to indicate the technical difficulties, Claude talks about *Hand Independence*, *Left-hand arpeggios*, *control of dynamics*, and *rubato*. At first, it does this at a general level, which could apply to almost any nocturne. Therefore, to test its ability to analyze what it has written itself, we ask it to be specific in explaining the difficulties and indicating in which beats of which measures they occur. The following is another extract:

> **Right Hand Legato and Phrasing:**
>
> - Measures 1-2: The ascending line from G to C (m1, beat 1) to B to D (m2, beat 3) requires smooth legato while crescendoing slightly. The challenge is maintaining connection through the octave leap from C to B.
>
> - Measures 3-4: The descending line from C (m3, beat 1) to F (m4, beat 3) needs to be played as one cohesive phrase, requiring finger substitution to maintain legato, especially from B to C on beat 3 of measure 3.

The results here are much more interesting. Beyond some examples of successes or inconsistencies, what is truly astonishing is the ability to connect more or less real difficulties with its own written score. In other words, it has some understanding of what's happening in the score and can intuit potential challenges. The accuracy of these insights is likely to improve as new models are developed and properly trained.

The difficulty mentioned above in bars 1 and 2, contains both correct and incorrect points:

- The total distance to phrase and connect is large, though the way it defines the boundaries is expressed in strange terms (citing the length of each bar) instead of referencing the overall range from the lowest to the highest note.
- There is a phrasing difficulty in connecting the two bars (with different slurs), but the reason stated (notes in different octave registers) is incorrect.

In an effort to achieve a greater level of pedagogical depth, we prompted the model to create technical exercises for studying its own nocturne in the style of Alfred Cortot[6] - a historic figure the model had previously assured

6] Alfred Cortot, a renowned French-Swiss pianist, is particularly famous for his insightful "working editions" of romantic piano repertoire, especially Chopin, Schumann, and Liszt. In these editions, Cortot included numerous technical exercises aimed at addressing the key challenges of each piece, helping pianists develop specific techniques required for their successful interpretation. His pedagogical approach emphasized musical expression while solving technical difficulties, making his editions a valuable resource for students and professionals alike.

us it was familiar with. Here is an extract from the explanation of the exercises created (**Figure** *3*):

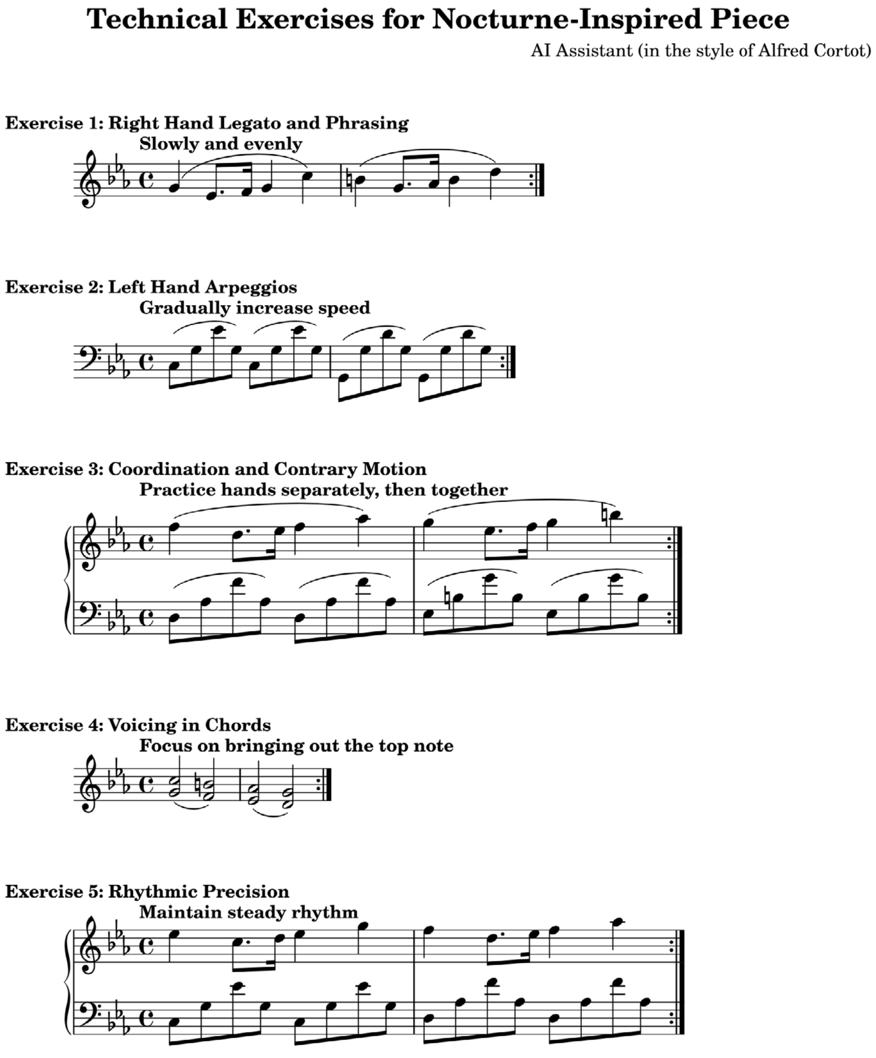

Figure 3. *Technical exercises in the style of Cortot, according to Claude 3.5.*

> **Right Hand Legato and Phrasing:**
> Focuses on the smooth connection between notes in the right hand melody.
> Helps with the challenging leaps (e.g., C to B) while maintaining legato.

Left Hand Arpeggios:
Isolates the left hand arpeggios to develop evenness and fluidity.
Includes the transition between different chord shapes (C minor to G dominant).

Coordination and Contrary Motion:
Addresses the challenge in measures 6-7 of the nocturne.
Develops independence between hands and control over contrary motion.

Voicing in Chords:
Helps with the challenge of bringing out the top note in right-hand chords.
Particularly useful for measures like measure 4 in the nocturne.

Rhythmic Precision:
Combines the dotted rhythm in the right hand with the steady arpeggios in the left.
Addresses the challenge of maintaining rhythmic integrity between hands.

To some extent, it is coherent in proposing exercises for the difficulties it had previously mentioned. However, these aren't truly Cortot exercises; it simply asks for fragments to be repeated and provides general (though correct) study instructions. Interestingly, the right-hand chords it once mentioned but hadn't written in the score now appear here.

It seems that Claude's training dataset no longer has the specificity needed to understand the mechanism of Cortot's exercises. Although we conducted more experiments with *GPT-4o with canvas* (largely unsuccessful), and asking Claude again for technical exercises on Chopin's actual nocturnes, we want to highlight here another new experiment in which we taught Claude to create an artifact capable of transforming Lilypond code into some of the typical technical exercises used to improve evenness in fast notes (Miralles-Bono, 2024a).

Link to test the Artifact:
https://beyondthepiano.jlmirall.es/2024/10/21/ai_fred-cortot-an-claude-artifact-that-helps-study-fast-passages-on-the-piano/

This artifact is capable of creating various common practice transformations from a Lilypond code provided with a musical fragment. Although in its current version it can perform 10 transformations, an example is shown in **Figure *4***.

Figure 4. Some pedagogical transformations of AI_lfred Cortot.

WILL MULTIMODAL MODELS BE ABLE TO IMAGINE, WRITE, READ, AND TEACH MUSIC?

The convergence of Large Language Models (LLMs) and music education is opening up exciting new frontiers. While still in its infancy, this technological revolution has already demonstrated remarkable potential. The ability of LLMs to handle and comprehend musical code, even at a basic level, marks a significant turning point in our approach to teaching and learning music with AI. But to realize this potential, it's crucial that we train these models to understand music as a written language, comprehensible in its complexity and nuance.

These technological advancements aim to amplify and extend human educator's capabilities, not replace them. The intuition, experience, and emotional connection that a human teacher brings to the learning process will remain irreplaceable. Instead, LLMs and other AI technologies can free educators from repetitive tasks, allowing them to focus on the more creative and personal aspects of teaching.

As LLMs evolve to deeply understand musical text, both aurally and in written form, and eventually merge with advanced audio models, their potential for music pedagogy and composition will expand exponentially. Rather than settling for "Another AI-generated Chopin nocturne, " we're moving towards a future where an "Artificial Cortot" could assist in studying any kind of music piece. This shift from AI-generated imitations to AI-assisted analysis and practice of authentic works represents a profound change in how we approach AI in music.

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9

Pluricreativism in Music: What posthumanism and new materialism makes possible for Future-Making in Music Education

PLURICREATIVISM IN MUSIC: WHAT POSTHUMANISM AND NEW MATERIALISM MAKES POSSIBLE FOR FUTURE-MAKING IN MUSIC EDUCATION

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ABSTRACT: Creativity is one of the most vital dimensions never more urgently needed than today in a highly dynamic and changing global landscape. Dominant conceptions of creativity in education are strongly framed by narratives of 'power-over' materials, context, and processes, especially where digital and technological applications reduce complexities between humans, materials, and environments. The separation of knowledge, tools, and bodies in 'disciplinary bounded', 'copyrighted', and 'patented' spaces such as in music education create a disconnect from our need for sustainable relationships, whereby the future is not given but 'in-the-making' (Haraway 2016). Drawing on music and music education research along with science education –as examples of distinct disciplines, often siloed and separated in education– this chapter advances nuanced understandings of how posthuman conceptions of 'thing-power'[1] (the power of all bodies including materials) and 'making-with' (whereby everything makes each other capable) contribute to the affective encounters of materialities within music education. By foregrounding the *sensing body* as a means to touch and be 'touched' by the world, I hope to contribute to invite new methodologies in music education research that illuminate the relational intensity of

1] The hyphening of words - such as with 'power-over', 'making-with' and 'thing-power' – is a posthumanist practice which invites new forms of engaging, reseeing, and thinking about the word.

material sensation as part of coming to 'know' and 'do' diverse creativities. In doing so, I engage with the performative work of several materialities of diverse genres and re-define the 'digital' beyond the delivery of preplanned learning pathways.

KEYWORDS: pluricreativism, posthumanism, new materialism future-making in music education

INTRODUCTION

Fostering 'pluricreativism' invites favorable conditions for pluralising creativities and change (Enrica Piccardo, 2017). . 'Pluricreativism' may well be a new word for you. It's potential for individuals to embrace a holistic, compex view of creativities and to experience empowerment in the process of perceiving and exploring a plurality of creativities, hybridity and interconnections, thus discovering and liberating their full creative repertoire, is becoming potential catalysts of change. With western countries moving from industrial economies to knowledge-based economies (European Commission, 2009), we see creativities realised for economic success (Sawyer, 2012). Like 'plurilingualism' which captures the complexity of applied linguistics and language education, we see 'pluricreativism' align with a complex vision of contemporary music education and diverse interrelational use which accepts multiplication of diversity. This is challenging.

Like me, you may find yourself often paused at critical junctures or times in your life that ignite and unleash curiosity, and imagination. I wonder and worry a lot about future-making in music education. I say wonder because McLure (2013) states that wonder can be explained as a feeling and state that belongs to the body, the mind or both; a state of suspension that tiptoes between knowing and not knowing, a way of making sense. She says 'it seems to be out there emanating from a particular object, image, or fragment of text; but it is also "in" the person that is affected. A passion: the capacity to affect and to be affected' (McLure, 2013:229). So, as music educators, should we aim to develop a more nuanced understanding of the interplay and dependency relations between humans and nonhumans, and the arts and sciences, in creative processes across a myriad of creativities.

Central to the idea of the vitality of matter and material forces that motivates all creativities, whether in culture and life, sciences and arts, is Jane Bennett's (2010) concept of 'thing-power' as the 'vital materiality' that runs through and across **sensing** bodies, both human and nonhuman; agency is distributed not solely the province of humans but rather a web of forces affecting music's materials, performers sensing bodies, **audiences, venues;** with a *'pluricreativism that moves within and between non/human bodies*. What if **pluricreativism** manifests as crystallisation of material forces? What then are 'new' creativities in music materialising? These times invite critique and questions about what we are doing to further understanding and increase our *collective creative quotient* in music's contemporary global society.

Across all musics, myriad creativities produce particular worlding performances that incorporate embodied movements and produce particular intensities of "making-with" (Haraway, 2016, p. 58) [2]. The artist's identity drives artistic practices of becoming/embodying art(s), that constitute and are constituted by a diffractive creation process. All knowledge domains, from the scientific to artistic, apply definitions of '**human creativity'** which uniformly privileges the classic criteria, of novelty and usefulness/effectiveness and utility (Kaufman, 2021). '**Human creativity'** is also equated with learning how to think, act and respond creatively (Kaufman, 2023); a promising means for transforming education, enhancing innovation and addressing real-world problems. But now, with technology and generative AI (nonhumans) which have catalyzed a radically new digital era in human history, we are living through what feels like an existential threat to 'human creativity'. How does this play out for creativities in music?

CREATIVITIES IN MUSIC AND MUSIC EDUCATION

It is no surprise why creativities research (which sees all creativity as inherently multiple and diverse) attests to the disruption of dominant framings

2] 'Worlding' as used by Haraway (2016) is an embodied and enacted process – a way of being attentive to the world with the whole person, where we engage in relentless processes of 'becoming with' a world in which "natures, cultures, subjects and objects do not pre-exist their intertwined worldings" (p. 13). "*Making-with*" is a term coined by Donna Haraway (2016, p. 58) which recognises that nothing makes itself but is in a constant state of 'becoming' with materials, environments, bodies and constructs.

of learning and teaching over the last twenty years. In light of the radical shifts that the twenty-first century anthropocene are producing in terms of what it means to be human (and more than human), the imperative for locating, differentiating and theorizing multiple creativities, generated by expanding domain-specific and domain-general approaches, involves forms of authorship (i.e., who and how creates) which are essential to education (Burnard & Colucci-Gray, 2020), including teacher education. The understanding and operationalization of seeing and doing things differently by deviating from established pathways are, as argued by Harwood et al. (2017), to confront head-on "the hegemony of developmental and neoliberalized conceptions of subject learning" (p. 176). In this chapter, we argue for a new vision for developing participatory practice possibilities for teacher professional learning that features the research-based development of diverse creativities as practice to catalyze environmental change in the school context.

Diverse and differentiated creativities urge us to rethink and re-vision the way we author new knowledge, new learning, and new ways of teaching in a world of fast changing educational landscapes (see Figure 1). Teachers find teaching for creativity and teaching creatively (Burnard & White, 2008; Chappell, 2018; Cremin & Chappell, 2019; Jeffrey & Craft, 2004) –along with documenting creative pedagogies in the years of formal

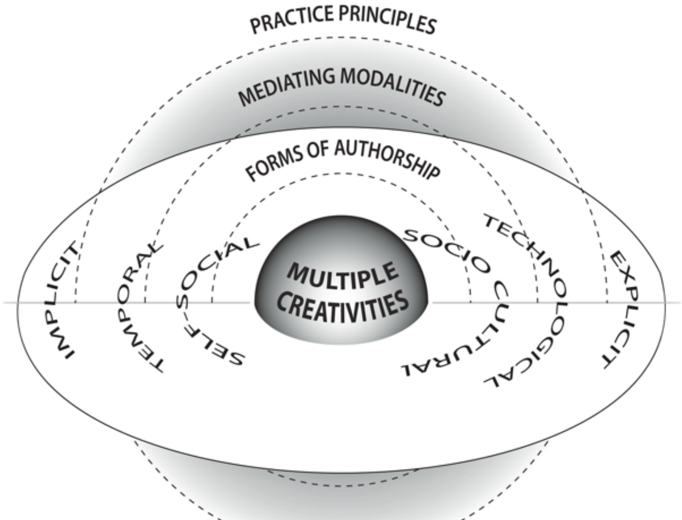

Figure 1 A model of multiple creativities

schooling– a challenge. In addition to this, there is an impact on student creativity demanded by standardization and risk-averse approaches. Yet there are still teachers and researchers who have found a way to ignite, enliven, and foster wonderment in their classrooms by educating for multiple creativities. I argue that acknowledging diverse creativities across an integrated creative ecology is effective in music education.

This chapter opens with the claim that, in the digital era, we need to go beyond the study of 'human creativity'. This is just too narrow. We know that there is a **myriad of creativities** that are materially lived, technologically embodied and embedded in ways that materialise as/in fluid and dynamic relational enactments that are co-composed, co-authored, co-created and co-cultivated in (human-centric/human-exceptional[3]) partnerships. We know that there are a myriad of **musical creativities**. We see and resee this in the ways bodies act, act on and are acted upon by technologies. What if we include the way nature pushes innovation forward in remarkable ways, co-authoring creativities that extend beyond the materiality of humans and include the materiality of earth, rocks and waterways? Most importantly, creativities can be highly contextualised and specific to (and in relation with) a place, a country, a culture, a time and environment. This could include the materiality of animals, earth, rocks or waterways, or a spiritually infused place grounded in cultural positionings, such that as bodies, they act, act on and are acted upon. Rosi Braidotti (2010, p. 409) calls these materialities the 'others', meaning the vital materialism of humans, nonhumans and things.

It is time to recognise that it is not enough to develop 'human-centric creativity' in children, in young people, in teachers, innovators and leaders? While I respect Robert J. Sternberg's argument that 'there is no single definition of creativity that fits all folk (implicit) theories or explicit theories. People, wherever they live, regardless of time or place, often adapt constructs to meet the challenges in their lives' (2021:8), I would add that creativities are relational, involving multiple actors and distributed agencies. Creativities

3] *Human-centric* … Human exceptionalism refers to the belief that humans are categorically or essentially different from nonhumans. One of the aims of this book is to make the case that humans (and therefore human creativity) are not the only significant actors (or way of authoring) in the world. Rather, a myriad of *creativities is co-constituted through thinking, acting and acting upon together in situated mutual intra-actions*, i.e. relational enactments that materialise differently in different creativities (Barad and Gandorfer, 2021; Stengers, 2017).

open up possible alternative scenarios, a dialogue with knowledges (Freire, 2005/1972) and a *vocabulary of pluriversal creativities* across multiple spaces.

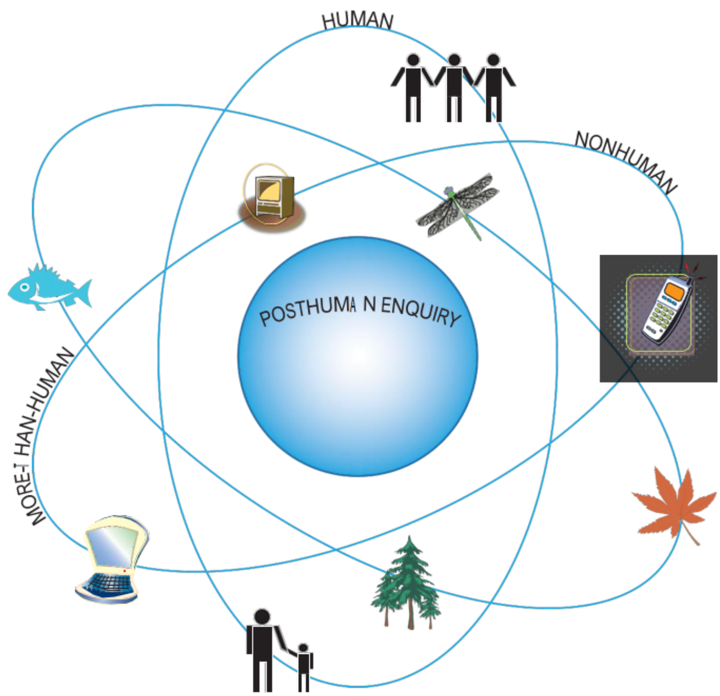

Figure 2. How we educate for posthuman creativities

MOVING BEYOND HUMAN-CENTRIC LOGICS OF CREATIVITY

Most people stereotypically homogenise 'creativity' to be a personality trait, mindset, skill or behaviour, an innate gift of a small number of 'creative' people. For many, creativity is a generalisable, universalised, measurable (even static, stable and fixed) human capacity which can and should be nurtured and developed in educational sectors. Some people focus on understanding 'mainstream creativity' (Hanson, 2023), while others theorise types of creativity drawing on psychometric theory (Runco, 2022) or 'everyday creativity' (Simonton, 2022). Researchers who study creative potential and human creativity draw from diverse perspectives such as psychology, philosophy, sociology and diverse cultural contexts (Glăveanu, 2019). According to Vlad Glăveanu (2012:196), 'creativity can be defined as a process of perceiving, exploiting and generating novel affordances during socially and materially situated activities'. In Glăveanu's (2013) five A's framework, the *actor* (the person), *artefacts* and *audience* (the environment) are equally weighted. Material and sociocultural *affordances* and creative *action* emerge out of actor–audience relations that both produce and are mediated by the generation and use of new artefacts (such as objects, signs, symbols, etc.) within contextual settings including physical, social and cultural environments. But what might produce different creativities and produce the materiality of creativities differently in a digital era? Then there are the 7 C's[4] that privilege human-on-human interaction: creators, creating, collaboration, context, creations, consumption and curricula (Lubart, 2017). What all of these perspectives on creativity share is the privileging of 'human creativity'. Another point here is that how individuals engage differently in different creative acts which differ in different cultural contexts. How does the role of materiality change? How are materials used as a force – even a partner – and why does what we create with matter? Why is the status of the shared materiality of all things *not* included, privileged or elevated when researchers research how creators create, collaborate in diverse contexts, making creations that may well be consumed and then featured in curricula? Where is the *shared materiality* with nonhumans (technology) and more-than-humans (multiple species in nature) that plays out in specific contemporary manifestations? Where is a more nuanced view and understanding that matters now, when serious commitment to an embodied life world raptured out of the bodies that matter of the utmost importance to education, society and culture?

For Hickey-Moody et al. (2016, p. 217), creativities connect materials, ideas and 'bodies ... becoming other than who they have been, and corporeal forms [change] physically and emotionally". It is this plasticity of 'form', involving the reshaping, remoulding and resetting of materials, ideas and self (as expressed through and with the body), that allows the spontaneity of 'meetings' – a multiplicity of engagements – and creates the momentum of diverse creativities. This onto-epistemological 'becoming' with the moments and momentum of creative doings, as evidenced in the

4] There are also the 7Cs of Learning Deisng (Conole, 2012); the 7Cs of Communication (John baird and Jim Stull, 2018); the 7Cs of consulting (client, clarify, change, create, confirm continue, close) (Mick Cope, 2010).

physicality of performing music, composing music or improvising music, or making-with materials in diverse genres, involves the openness and 'response-ability' (Haraway, 2016) of a 'body-mind' (Murris, 2016) to what is forming. This view of 'form' – not as a container made by pre-existing, pre-determined constraints abstracted from self – is significantly different from many research forms (as structures, material organisers and ontological ways of being creative) that we, as music educators and music researchers, encounter in our work. So how *should/can we* trouble narrowly defined views of musical creativity and come to see the actualisation of a meeting-point of multiplicities in musical creativities?

Like artistic research, artistic practice offers a combination of past and future in the present moment, along with new understandings of how, when and where we are "making-with" each other and the world rather than merely creating representations of "reality" (Barad, 2007, p. 139). Using diffractive analysis, we seek to de-couple the specific language of a discipline from its original context to open up new possibilities for making-with disciplines. Transdisciplinarity de-territorialises creative practices, producing a new type of transdisciplinary creativity, and generates new ways in which making-with becomes an experiential, exploratory, generative activity. Disciplines can thus be untangled to make new, posthumanist re-seeings of the potential for decentring the human and recognising the role of more-than-human elements, shifting our notions of materials from inert things waiting to be manipulated by human skill and control (Ingold, 2009) to active "ontological heterogeneous partners" (Haraway, 2016, p. 17) engaging with us in "material-discursive" practices of becoming-with and experiencing-with (Murris, 2016, pp. 6–7).

This chapter takes up the feminist new materialist concepts of *diffraction* and *diffractive analysis* as way of enquiring into the *ontologies of difference* and *relationality* that underscore the interconnectedness of practice and research that scholars routinely work with, particularly when trans(disciplinary) mattering involves musical enunciations and gestural composition, in which the physicality and kinesis of playing are central to the sonic result. [5] What does this mean in the repetitions of pitches (i.e., motives and phrase of a melody) for compositional creativity?. What are the generative and productive performance creativities – and mattering – that are multi-

5] 'Musical enunciations' is a term coined by Stoianova (1993), who considered the working of graphic scores works and gestural compositions as non-fixed objects in favour of process, play, experimentation, multiplicity and multi-directionality, with a disregard for effacing the compositional subject and object.

ple, complex in generative sites where audiences "become in-tune-with" (Taylor, 2020, p. 5) in order to re-see, re-hear and re-sound these pitch patterns and passages composed earlier and now performed in relation to aspects of the world that can be classified as human and nonhuman (musical instruments, objects, spaces, silence, technology)?

A new materialist understanding of music (and sound studies) is offered by Finnish researcher Taru Leppänen at the University of Turku, in a study of the musicianship of a Deaf Finnish rap artist who uses international sign language and a performer/collaborator who sings in English. Through an analysis of the materialities and their affective interplay (e.g., human bodies and sound waves mediated by air/technologies), as well as Deleuze's views concerning the processes of relating to and creating in connection with Deaf cultures, beyond the territory of human hearing, Leppänen (2014), diffractively analyses the vibratory materialities of *making-with sound*. In another project, Leppänen and Tianien (2018) explored how *materiality – or materialities –* matter a great deal in trans ways of being or becoming and the unfolding of trans selves. In particular, she engaged with Derian Seesjärvi, a classically trained singer, by asking how his artistry and music-cultural field of classical singing and performance creativity prompt insights into the co-formations of body, voice and sex/gender in trans ways of being. In this study she asked: How can new materialist ideas embrace the emergent, instead of passive or predictable, character of matter, and the intra-action/intra-active occurring of materialities underpinning performance creativity?[6] Other examples of diffractive analyses in music research focus on the field of gay and lesbian musicology. In *Queering the Pitch*, Cusick thinks with an "assemblage of notes that constitute the less private parts of an interior conversation among the several selves I am" (Cusick, 2006, p. 69) to expose the territorialisation of gender, bodies, musics, the creativities of making and the institutions which constitute musicology. At the centre of Cusick's readings are calls for an ontologically different way of engaging with music, most notably the statement that "I try to treat [music] analytically as I would be treated: as a subject who may have things to say that are totally different from what listeners expect to hear" (2006, p. 76).

6] 'Intra-action' is a Baradian term used to replace 'interaction', which necessitates pre-established bodies that then participate in action with each other. Intra-action understands agency as not an inherent property of an individual or human to be exercised, but a dynamic force in which all designated 'things' are constantly exchanging and diffracting, interacting, influencing and working inseparably (Barad, 2007).

Similarly, Hickey-Moody et al. (2016), exploring an interdisciplinary university course involving expressive physical movement, utilise a diffractive reading of dance creativity as a way of resisting "the hierarchisation of one type of meaning over another" (p. 217). In doing so they illuminate the inseparability of students' bodies from their environment, exploring how diffractively reading across and between different media and boundaries creates spaces for theorising, creating and producing diverse creativities as simultaneous practices. In another study, Hickey-Moody (2020) explores how primary-school children make art, using diffraction as a way of thinking that "draws attention to the agency of the nonhuman, the ways that the materials used to make art can change thinking and change relationships between people … building more than human relationships" (p. 731) and troubling which creativities we are educating for. Insights from these studies show the relevance of new materialist approaches to myriad creativities in music.

What if we could unleash the vital materiality that powers a myriad of musical creativities to productively respond to uncertainty? For example, given an increasing realisation and acceptance of the need to engage more inclusively with arts practices, moving STEM-to-STEAM, and learning for sustainability in educational systems across the world, teachers are increasingly turning to develop alternative ways of learning, engaging with music, deepening how sensorial encounter that can complement passionate use of sound art and technologies, featuring both human and nonhuman actors and the specificity of place. **What do we need, then, to stop the ongoing marginalisation of music in education? How should we go beyond the disciplinary and institutional comfort zones, inviting new authorings, new crossings, with contemporary real-world practices of professional musicians to reveal how a multiplicity of creativities empower and sustain professional musicians who venture across music and creativites industries, beyond the expected? What benefits are there to thinking about differentiating and distinguishing between creativities, given that the music and creative industries are made up of myriad creativities and forms of creative labour? What do we gain by (and miss) thinking of it this way?**

By developing pluricreativism - which captures the dynamic, situated and complex relationship between place, cultural trajectories, sound, sonic arts and languages, both teacher and learners become creative players and creative playmates in living and teaching this aspiration - which assumes humans, nonhumans and more-than-human distributed agencies.

What if pluricreativism **material powers** circulate around, within and between humans, nonhuman life and things as *new knowing*? What if, the '**thing-side of affect' and 'vitality' of musics** and sonic arts experiences whether inside a concert hall, a music studio, a club, or in an immersive 3D video game, manifest the materiality, relationality and distributed agency, as defined by Jane Bennett (2010, p.viii) ' [to] do things that make a difference, produce effects, alter the course of events', where human-nonhuman creative agency is distributed? This chapter draws examples and insights from a soon-to-be-published book (*Pluralising Creativities: What Posthuman New Materialism makes Possible for Future-Making Education* (2024 Brill-i-Sense) and a recently published book '*Creativities in Music Education*' (2023) Routledge), both whose central tenet is that **humancentric logics homogenise creativity** and is simply no longer responsive to current industry and education challenges. This leads us to rethink what music educators are modelling in their practices. This leads us to rethink the materiality of musical creativities? What is the role of the sensing body and the materiality of the body in diverse musical creativities? How are they enacting the real world plurality of creativities in music?

Sensing bodies

Both science and music education make-with sounding, sensing bodies, where reverberations (audible, felt and observed) spread, make and disrupt through sensing intra-actions with materials and through the music of objects. And yet, as bounded disciplines with strict modes of being scientist / musician, these reverberations, these moments of making-with, are often bounded in both language and relationships. Similarly, some disciplinary practices within education downplay vital relationalities, where encounters with the materialities of disciplines, especially those with specialist material equipment and patterns of engagement - such as sciences and music - are considered subservient to human cognition, of either teachers or learners. Here the role of *the sensing body*, and *the materiality of the body*, particularly *touching encounters* through the hands and fingers, but also through the ears vibrating at the 'touch' of sound waves, are often undertheorized in relation to knowing. Specifically, conceptualising 'touch' as a way of knowing can be understood as a reversal mode of being touched and touching (Merleau-Ponty, 1968, p.138), where "the act of touching inverts the subject-object relationship, disrupting the boundaries between self and other" (Stewart 1999, p.31).

As illustrated by Parke and Plutinski (2020), biologists go about producing their theories and explanations, literally by building and manipulating their own, tangible, constructed models. Embodied thinking, or thinking through and with the hands, posits the body as the threshold of experience, of touch as a way of knowing and encountering self and other, is connected to linguistic and reflective capabilities. Hence neither the scientists nor the artists can be detached, unchanging observers, and instead their 'artful empiricism' (van Boeckel, 207, p.145) lies with their being participant, present to the lives of others as they unfold.

In this sense, both music and science are not reductively concerned with the pre-sensorial identification and reproduction of either physical or musical 'objects'; but both scientific and musical knowing are made-with, in a state of attentive receptiveness to the intense vibrations of matter, which are at once internal and external to the body (both human and otherwise). Almost a century ago, speaking of the role of the body in aesthetic knowing, Dewey (1933) described: "sounds come from outside the body, but sound itself is near, intimate; it is an excitation of the organism; we feel the clash of vibrations throughout our whole body" (p.246), whereby the reverberations of our human-material, posthumanist realities, past-present realities are felt.

To make-with therefore requires us to be vulnerable and yet open to the possibilities that emerge from our intra-action with the thing-power of entanglements. As Rosi Braidotti argues, embracing this vulnerability is an "express[ion of] the deeply affective and relational nature of all living entities" (Braidotti 2019, p.169), which she goes on to contend is a "vital bond" for "generative power" (ibid.169). It is this generative power of making-with, as a way of making differently-new-beyond expected disciplinary modes, as transformative to self and each other, that Lenz Taguchi (2010) maintains is not equated to forcing change. Rather, it requires us to be minoritarian, "put[ting] ourselves in a state of becoming-other [where we deliberately pay attention to] change and changes in ourselves, but also in the [material]" (Lenz Taguchi 2010, p.172).

Therefore, to be minoritarian is *to attune to* and make-with the materiality, the particular thing-power and what it offers to our relationships. As we will further articulate in the paper, this is a vulnerable and creative space, where uncertainty about where such making-with takes us together, challenges educational practices of linear progress and pre-destined outcomes. *To attune to* is both a methodological and ethical stance, that invites what is possible, and therefore what we can make-with the materiality of our encounters. Explicitly acknowledging the sensing body in knowing - and the potential this has for making-with - opens the space for pluricreativism in music as I explore through our empirical cases.

THE VITALITY OF MUSICAL MATERIALITY AND PLURICREATIVISM

The concept of 'thing-power' gestures towards the strange ability of ordinary, man-made items to exceed their status as objects and to manifest traces of independence or aliveness, constituting the outside of our own experience, such as we see with musical instruments (Bennett, 2010, xvi). Thing-power emerges from within materials as a presence that acts upon us: Bennett refers to this as "the capacity of things…to act as quasi agents or forces with trajectories, propensities, or tendencies of their own" (2010, p. viii). Furthermore, Bennett suggests that "we are vital materiality and we are surrounded by it" (2010, 14). So, if materials are a source of action and actioning, as evidenced whenever instruments are laid out in a classroom of young children, or observed when an audience attends a concert, : they can make demands through their specific characteristics to provoke us in multiple and playful ways. Things come to matter as cultural and playful formations, extending meanings through connecting between-across-with multiple senses (Massumi, 2002).

As **musical instruments are played**, materials move and form alliances with other materials, and through their playful entanglements with each other bodies, instruments, spaces and sounds become material partners. The vital materiality of play is thus conceived as active and forceful and the body is centrally imbricated: "in manipulating music, we simultaneously manipulate not only the environment but ourselves" (Krueger 2015, 52). As such, performers' bodies are not taken as isolated from the instruments that they engage with, and objects are "transformed and invested with new meanings that reflect and assert who we are" (Attfield 2020, synopsis). The material intra-actions that shape many musical creativities take their cue from improvisatory practices, cueing, intersubjectivity [and] entrainment" (2014, 197), but can be added to by music's enfolding of sonic, spatial and material relationships. The materiality of sounds and relations that arise from the messiness of surprises and new possibilities inherent within the materiality of musical creativities are particularly activated in performance creativities across diverse genres.

THE MATERIALITY OF PERFORMANCE CREATIVITIES ACTUALISED ACROSS GENRES

Materiality of Performance Creativity in Heavy metal: a primal performative "playing" in heavy metal occurs at a sonic material level, through the essential element of distortion (Mynett 2016) which transgresses the clarity (and apparent beauty) of the sine wave. The creation of a "dirty" tone can easily be linked to symbolic notions of impurity (Douglas 2002), which implies the potential for a playful messiness. Similarly, the common usage of dissonant intervals such as the flattened 2nd and the tritone (Berger 1999) can also be seen as transgressive play-acts which challenge harmonic normalcy (Shadrack 2021). Importantly, the materiality of performance creativity in metal music avoids total transgression (i.e. chaotic noise) for the most part, situating elements such as extreme distortion and chromaticism within recognisable song structures and riff patterns, even in the most technically-focused subgenres (Smialek 2016).

Materiality of Performance Creativity in Western Art Musics manifests through a greater than normal bandwidth for timbral variety, manipulating the materials available in innovative ways, such as using novel rhythmic stress patterns, pushing various timbral extremes including an exaggerated portamento on occasion, and manipulating sounds away from the conventionally beautiful. This is can involve a play *with* and *within* materials. Equally, there can be a metaplay of materials themselves. Sometimes structural and simpler melodic elements come to the fore, revealing a counter-cultural interpretation that seems to play with the materiality of "the soloist" role. Such micro-variations are not always obvious, but this is nonetheless an agentic form of play with consistent interpretative micro-variations along with exploration of highly polished repeat performances where "liveness" becomes a space with a play-resonance between prepared and "in-the-moment" narratives. Equally, there can be transitions from the presentational to the participatory (Turino 2008), evidencing how the one can be playfully nested within the other, despite the dominant hierarchical narratives of the physical concert environment. Equally, a material play can emerge within the encore of physical engagement between the stage, and dialectical audience and participant status orientations; of sound from stage and from hall, of material clarity and precision with muddled and blurred audience contributions. This is alongside the play of language, meaning, form that is actualised as performance creativity by people coming together and move together in harmony, sharing a melody, or accentuate a rhythmic passiage with synchronous precision.

Materiality in the performance creativity of jazz can involve many possible fields of play. Silences can mark the beginning and the end of musical phrases, disrupt and enhance the musical flow, and can be tangible presences. Jazz musicians have an acute, and often intuitive, awareness of this relationship, and there is evidence from music psychology that, as listeners of music, we perceive musical notes in their relation to the silences that shape them (Margulis 2007). Yet in the intra-action between matter, sound performers and audiences, silence is a performative creative act, a material which has both social and musical significance. Jazz musicians feature silence as a play mechanism. They use silence to great effect, sometimes creating a distinct authorial voice making visible the embodiment of play as sounding oneself, a form of self-crafting (Henricks, 2015).

Materiality in hip hop/ rap

BREIS is a London-based Nigerian hip hop/rap/jazz artist, educator and CEO of Student of Life Ltd, a hip hop education company and record label. BREIS (Brother Reaching Each Inner Soul). He takes the creative, vibrant energy of hip hop performance creativity and applies it featuring the use of storytelling, BREIS's Hip Hop Literacy program aims to make learning more fun and provide an understanding of hip hop, whilst simultaneously improving literacy skills. Through active engagement, students share part ownership of the performance and their thoughts and feelings, validating their expression irrespective of spelling and grammar. In this way, students expose their vulnerability, writing skill and knowledge of self. BREIS (pronounced Breeze) maintains that knowledge of self, which he argues is one of the pillars of hip hop, generates understanding of who we are and how to live peacefully in this world. Making this a fundamental part of learning is for BREIS crucial to our future wellbeing (see BREIS, 2022). Here is an example of the materiality of language use in compositional creativity which comes to life manifest with performance creativity.

Heavenly sent to me so it was meant to be
I'm already mentally who I'm meant to be eventually
They couldn't see this entity's intensity immensity
Didn't invest in me, but that wasn't my destiny
Don't mess with me, God-given energy

To crush my enemy like a centipede, but I'm friendly
the mic is my girl. At 10 to 3, secret assignments to MC
I'll do it for free but first pay my rent for me
I'm ebony and everybody's telling me
How to be, I won't let it be a dent in me
Let me be me, the best in me is yet to be
Don't need an ID card to show you my identity
In a class of my own I tend to be essentially
A student of life, it's elementary
Not me, but a conduit I get to be
The Word in me is next to me; spell my name

This world is full of lies, everybody's in a guise
Despise and diss guys in disguise that spit lies
A bit wise behind my eyes and behind my disguise
I'm a fat guy mistaking MCs for mince pies
Throw your hands in the air, reach for the skies
I rise till I realise: I am the prize
But don't be surprised when I enter-prise
I'm blessed, I'm a blessing, I'm blessing in disguise
Disguised in a body – soul, spirit
My whole lyric no limit, so go get it
Why did he did it? 'cos flows is good for his health
Bona fide Rhymes Exist In Self
(BREIS, 'Identity')

So, why is it that music educators, across a spectrum of sectors, rarely feature hip hop in the classroom and make little use of a cultural area which is of immense importance to huge numbers of young people? Hip hop struggles to find a place in the mainstream school curriculum, at least in the UK. Creative practice with DJ decks is a key mode of music making within contemporary urban musics, but is very different from the practices found in popular music and Western art music, which most music educators are at home with. DJing, MCing, beat making and rapping are rarely practised in schools and are marginal in higher education, yet these modes of music making can have transformative effects on young people, not only for their musical learning and understanding but also for their self-confidence, mental wellbeing and much more (Glenister, 2018). There is an urgent need, therefore, for music educators to recognise myriad creativities in music, for what they are, in the twenty-first century, which is hugely important to great swathes of young people (many of them from Black, Asian and minority ethnic backgrounds) that need to find self-expression, empowerment and healing.

RECONSIDERING THE ONTOLOGIES OF MUSICAL CREATIVITIES

The centrality of materiality can no longer be dismissed. We need to invite discussion about musical instruments and musical bodies, the objects and the thing-power they possess in moments of encounter and performative engagement. These materials enact play forces and empower exploration of the generative possibilities of performance practices, compositional practices, listening practices and more. Bodies are authors. Both human and nonhuman bodies are coauthors and hosts of musical creativities. WE need to step aside from culture of bodies as devalued tools of sound production

When thinking about developing and refining the material cultures of music education settings there are questions that we need to ask ourselves: what immanent play forces, play things, or play gestures are conventionally assigned to different music genres? What emerges through the ontological lens of play in how music materialises its social, philosophical, genre-specific historical situatedness? How does the force of play materialise in our teaching studios as a driver of collaborative and interactive musicking through the complexity of objects and their exploration? How can the materiality of notation make playing a score into an exercise of agency rather than reproduction? (Schuiling 2019). It is difficult to address its function since the usual conception of notation in music scholarship is at odds with studying performance in the first place. This article presents a methodological outline for an ethnomusicology of music notation by investigating the musicality of notation not in terms of its representation of musical structures, but in terms of its mediation of the social and creative agency of musicians. It is suggested that, rather than detracting from musical reality, notation composes musical cultures. This constructive work is simultaneously ontological and ethical. It is described in terms of three distinct processes, namely mobilization, entextualization and remediation. In doing so, this article presents an interdisciplinary approach to a topic that has traditionally defined

the disciplinary centre of music scholarship.","author":[{"dropping-particle":"","family":"Schuiling","given":"Floris","non-dropping-particle":"","parse-names":false,"suffix":""}],"container-title":"Journal of the Royal Musical Association","id":"ITEM-1","issue":"2","issued":{"date-parts":[["2019"]]},"note":"Great article - see highlights. mostly against the performative turn going too far on notation. \n3 main arguments:\nMobilzation (notation gathers us into action).

I believe that music education performance studies should be empowered to articulate material tracings of play in bodies and their relationships with sounding objects and the physical world, exploring the human condition through musicking as material play with sounds and with selves. Rather than seeking a generic or universal performance model, for example, can we restore in play the temporal specificity of *these instruments, this acoustic, these bodies* and reject the imposition of *this interpretation, this styling, this sound quality*?

CONCLUDING THOUGHTS

While I would have liked to draw on more exemplars of a myriad creativities in music, thus affording the opportunity for a plurality of educational experiences supporting an array of diverse creativities, time permitted a brief mention of only a few diverse genres were featured. We know, however, that if education is to be **future-making, then it** needs to unravel, unsettle and rupture, to get underneath the skin of diverse and multiple creativities, in the uncertain terrain of unfamiliarity. Such diverse creativities however are not neutral capacities, but they develop within and in between the constraints and the opportunities of diverse practices and genres in music.

In the face of educational challenges, we need to consider how our human and nonhumans and more-than-humans co-construct distinctive capacities, and distributed agencies, as well as delineated, disciplinary areas can be literally 'put to work' in a holistic and synergistic way. We need to be able to see the relationships and interdependencies across a myriad of musical creativities and amongst and across disciplines in the same way that we need to understand and *feel* the relationships and interdependencies within the natural world and our part in that complex web of life.

As Tim Ingold (2014) argued: 'the capacity of living, growing things continually to surpass themselves' (p. 128). The capacity of music creativities in education to create meaningful learning, requires teachers to be supported and to collaborate.

When myriad musical creativities – or pluricreativism - is considered in this way, it is worth exploring what kind of *change* is implied in this pluralising. By pluralising creativities, inherently involving an ethico-onto- epistemology, that is, researchers are entangled with the phenomena being explored and the methodologies used, *change* is entwined across both methodological and pedagogical process. Boden et al. (2021) remind us that this kind of *change* is not something 'out there' to be found, or a future to be envisioned in a linear progression, but is an emergent phenomena that enfolds through its exploration. Similarly, Amsler and Facer's (2017, p.1) positioning of educational futures are influential here as they forefront the role of critical anticipation which "assumes an active and critically reflective interaction with futures that are unknowable".

I conclude with an invitation. It is our responsibility as music educators to strive towards a relational pedagogy that helps children, young people and ourselves to develop novel, interesting, clear and diverse programmes that invite students to release a diversity of creativities.

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Tone, gear, and timbral choices: An autoethnographical exploration of the intersection between the music industry and music in higher education

TONE, GEAR, AND TIMBRAL CHOICES: AN AUTOETHNOGRAPHICAL EXPLORATION OF THE INTERSECTION BETWEEN THE MUSIC INDUSTRY AND MUSIC IN HIGHER EDUCATION

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ABSTRACT: This co-autoethnographic research chronicles the journey of an undergraduate student who was interested in the relationship between intentional timbre choices and end musical products. The lines between individual roles or specialized musical roles are becoming more homogenized due to the prevalence and emergence of ubiquitous technologies that have transformed how music is produced, consumed, shared, and experienced by society. Music teachers have started to embrace their potential to serve as music producers of their students' original music in classroom and studio settings (Randles, 2022). Tone, gear, and timbre choices contribute to our understanding of artists (Fink et al., 2019), their creativity, their musical development, their social and cultural impact, and their place within a larger network of technology and music industry. The researchers provide implications for both music industry and music education as a result of this work that includes teaching undergraduate students about 1.) tone and timbre in relation to the gear that helps musicians achieve their intended aural/sonic goals, 2.) psychoacoustics and biases in relation to critical analyses of what they hear in music, and 3.) how industry has shaped and formed those choices historically, now, and into the future.

KEYWORDS: popular music, creativity, sound design, sound studies, online learning

INTRODUCTION

Michael Mark suggests that music education has had a more secure place within the curriculum when it satisfies the prevailing needs of society (Mark, 2015). At the end of the first quarter of the Twenty-First Century, ubiquitous technologies for recording (Chanan, 1995; Shuker, 2013), performing (Toynbee, 2016), and sharing music are at the forefront of public interest in music. Music industry is constantly changing and adjusting to the current needs of professional musicians who contribute to the public's need for specific musics—of both the recorded and performed live variety (Turino, 2008). This research chronicles an undergraduate music student's journey within performance, industry, and education circles as he grappled with what the intersection of these areas means for the place of ton, gear, and timbral choices (TGT) within the curriculum.

The two authors wrote this chapter as a part of Author One's (A1) independent study with Author Two (A2) for work towards earning his undergraduate degree in music performance. The two authors met while performing the guitar parts for a professional presentation of the musical Godspell in the Spring semester of 2021. A mutual interest in TGT in music performance led to A1 requesting an independent study with A2 to explore what their common interests might mean for the future of music industry and higher education music (Fink et al., 2018). They undertook a number of projects that led to the design of a course for teaching tone, gear, and timbre. The course design and development quickly led to opportunities to share their journey in various forms.

Here we utilize a co-autoethnographic, double hermeneutic approach in chronicling our journey (Ginev, 1998; Jensen, 2019). A2 could see in A1s work a passion, precision, and ability to theorize and practically execute a wide array of musical and analytical skills that were worthy of encouragement and nurturing. His brilliance was on display week by week as we met to discuss how things were going in the development of his course for teaching TGT. A2 suggested that it might be a good idea for him to write about his experience as a way of processing the things that he was learning as he developed the course as other musicians and music educators would likely need to do the same. Topics from our lives as professional performing guitarists were frequently discussed over the course of the semester as they relate to the kinds of things that music teachers need to know to teach their students about TGT and the kinds of things that music industry wants to know in order to better cater to the needs of primary, secondary, and higher music education. At this time, it is important to know where the authors come from.

AUTHORS

A2 is a music education professor at a university in the southwestern region of the United States. He teaches courses in contemporary musicianship, creative thinking, and popular music for music education majors at a large research university. He is also a professional performing artist on guitar and voice within the region. A1 works in the popular music department of a small liberal arts college in the area near A2's institution. In some cases, students at A1's college continue on to become students at A2's university. A number of the faculty at A1's institution were prepared by attending A2's institution. A1 was then a student at A2's institution. The motivation for A1 was to learn as much as he could from A2 about their common interest in TGT. A2 saw the potential for the co-construction of new knowledge among the conversations that the two had over the course of the semester. This chapter is the sharing of their journey in the form of research.

LITERATURE REVIEW
ONLINE LEARNING IN MUSIC

The two authors met over the course of a semester in an online format. Learning online in music and music education has been studied and philosophized for the better part of two decades (Bowman, 2014; Brown, 1999; Cremata & Powell, 2017; Koutsoupidou, 2014; Kruse & Veblen, 2012). Waldron has studied online learning over the previous decade with much depth and rigor (2011, 2013a, 2013b). Findings of this work include elevating the status and perspective of the quality and richness of the work that occurs in online music-making and music-learning settings. Online instruction in music is not a passing fad (Vivolo, 2016), or something for the music education profession to marginalize. People can learn well in online environments (Horspool & Yang, 2010). These experiences are meaningful and often connect them to a community of like-minded individuals (Kruse & Veblen, 2012) from all around the world. Some of these communities have centered around the ways that music is created, recorded, and shared.

MUSIC PRODUCTION

Music production has been researched in music education since the 1990s. Researchers have explored cloud-based music sharing (Thorgersen, 2012), the role of computers in the digital music-making process (Brown, 2007), the values of digital music-making to musicians (Partti, 2014), the role of technology in the creative lives of musicians (Burnard, 2012), and the power of digital technologies to transform classroom experiences (Bauer, 2020; Ruthmann & Mantie, 2017; Wise et al., 2011). Music production (Dunbar-Hall & Wemyss, 2000; Walzer, 2016; Webster, 2016) has grown in prominence over the previous decades in music-making that occurs inside and outside the music classroom (Haning, 2016; Mark & Madura, 2013). Webster has written that music education should create an augmented space for these new and emerging forms of music teaching and learning. The education profession, including music education, has been working to create a space for more digital music creation that empowers students, facilitates autonomy, and fosters individual creativities (Burnard, 2012). Recognizing the necessity for the profession to included opportunities for original music creation in the curriculum, music educators have given considerable attention to the role that technology plays in affording these opportunities.

TECHNOLOGY IN MUSIC EDUCATION

Burnard (2007) suggests that the proliferation of technology in the experiential worlds of students and teachers in music education focuses our collective theoretical and practical efforts towards understanding how it encourages pedagogic change. Technology can provide a means to an end, but it can also provide completely different ways to think about pedagogical possibilities and potentialities. Music instruments—tools for the instrumental musician—have been in constant development over the course of human history (Roads, 1996; Sachs, 2012). The history of these instruments follows a path that Wise et al. (2011) label *amplicative* and *transformative* (p. 120). Technology can rapidly extend the experience of students (amplify) and take it to new and quite often exciting (transform) places. Musical instrument technology does not only include the instruments themselves, it also includes a number of devices that fall in the audio signal path of those instruments.

TONE, GEAR, AND TIMBRE

Musicians have been constantly developing their tone through technological—both analogue and digital—means for the better part of the past 100 years. The ability to record audio in 1860 with Édouard-Léon Scott de Martinville's recording of "Au Claire De La Lune" ushered in a new era of thinking and practicing through recorded versions of sound. Zagorski-Thomas (2018) discusses the shaping of "sonic cartoons" in recorded music. He borrows from Smalley (1986) in describing a spectromorphologic landscape of sounds that can be studied, understood, and replicated in future work. Particular sounds invoke particular reactions from listeners based on the history of their use and how listeners have commonly and perhaps uncommonly interpreted them.

Tone is something that all musical utterances contain. Tone might be defined as the quality of a musical-sound expression—pitch, quality, dynamics. Timbre, a closely related term, is the quality of a musical sound or voice as opposed to its pitch or intensity. Fink et al. write about the slipperiness of the terms tone and timbre in that there are systems for interpreting pitch and rhythm (among a host of other musical terms), yet an intricate system for interpreting tone and timbre is not yet widely accepted (Fink, Wallmark, and Latour, 2018). Nonetheless, tone and timbre shape and refine the sounds of popular music (Butler, 2018), and to a larger extent all of music. The teaching of tone and timbre in the context of music education is something that is still in a period of infancy (Randles, 2022, 2024; Walzer, 2016).

PURPOSE AND RESEARCH QUESTIONS

The purpose of this co-autoethnographical work was to explore the intersection of music industry and music education by chronicling the development of a course on tone, gear, and timbre choices among a music student (A1) and a university faculty in music education (A2). Solutions for dealing with the terminology of tone and timbre need to be dealt with in all of higher education music, including music education. The authors worked together on a course that would address these needs for secondary through college-aged students. The specific questions that framed our independent study were:

1.) In what ways do musicians talk about their tone that can be taught to others?
2.) What specific gear do musicians use to accomplish their unique timbral variations?
3.) How might music educators introduce tone and timbre to their students?
4.) What role does timbre play in the nurturing of creativity among music students?

These study questions helped us frame the development of the course and led to the development of these specific research questions:

1.) In what ways can TGT be introduced to all undergraduate music students?
2.) What aspects of TGT should music teachers be concerned with?

METHOD

The two authors write this chapter as a part of A1's independent study for work on his undergraduate degree in music performance. We utilize a co-autoethnographic, double hermeneutic approach in this study (Ginev, 1998; Jensen, 2019). A2 could see in A1s work a passion, precision, and ability to theorize and practically execute a wide array of skills and dispositions for making use of TGT. His brilliance shined from week to week as we met to discuss the connection of higher education music to music industry through an understanding of TGT. A2 suggested that it might be a good idea for him to write about his experience as a way of processing what he was learning. As A1 was very new to the idea of doing research, A2 began a discussion of how autoethnography is being used in diverse fields to bring the perspectives of researcher/practitioners to "engage in memory work ... to reflect on, record, and report our experiences living through time, space, and circumstance" (p. 3, Adams, Jones, & Ellis, 2022). Autoethnography is one of a number of tools in qualitative research being used to discuss new and challenging topics with rigor and relevancy.

Over the course of the semester A2 encouraged A1 to keep a journal, write down talking points for discussion during independent study times, engage in exploring the literature regarding TGT. The work that emerged from this process was fascinating. After approximately seven weeks of doing extensive literature reviews, having engaging discussions regarding process, and reflecting upon experience, A2 encouraged A1 to put his thoughts down in the form of an autoethnography.

Double hermeneutic approaches allow for concomitant production of meaning and meaning-making within the research process. A1 and A2 are practicing professional guitarists who have lived and worked through similar social situations, shared much of the same experiences, and were therefore keenly positioned to extrapolate meaning from experiences with the potential to add to the literature in the area of the intersection of TGT, higher education, and the music industry. A2 was in a position to share with A1 how research can flow from reflective and impactful practice. This methodology and our analysis allowed for both authors to live out their normal roles, and use those roles to provide credibility for the results and implications of the study.

We discussed how autoethnography is often used to help researchers process their experience in a way that invites an open dialogue between readers and their lived experience by reading a handbook of autoethnography (Adams, Jones, & Ellis, 2022). A1 agreed to chronicle his experience in a way that would be approachable by musicians like him. The autoethnography that follows is A1 writing directly to his imagined readership, musicians who may find themselves in a similar situation—desiring to teach TGT concepts. What follows is A1's experience and practical advice for them.

THE RELENTLESS PURSUIT OF TONE—AN UNDERGRADUATE'S JOURNEY (A1)

The search for tone is a journey every musician makes. This is a journey that lasts their entire life. Tone is an immensely personal endeavor; it taps into our very identity. It is our representation of our authentic selves and is shaped by everything we encounter.

Every note is a sonic fingerprint and unique identifier of the player's greatest joys and deepest tragedies. An instrument's timbre is something that we tend to notice before anything else sinks in. Before harmony, before rhythm, we hear the distinct tonal characteristics of the artist and their instrument. Individual idiosyncrasies, technical prowess, and technology all combine to produce an aural representation of the soul laid bare for all to hear. Now more than ever the integration of technology and the emergence of industry has allowed musicians greater control and manipulation of their tone and has made the quest for identity simultaneously easier and more difficult. Eventually, you figure it out and do your best with what you have right now.

The journey and collective experiences inform the endpoint.

In the beginning of my musical journey, I tried to follow a path that would allow more opportunities. I spent most of my time academically playing the saxophone and studying Western classical music while moonlighting as a guitarist for musicals and recording sessions. I was defining myself as a saxophonist first, because I was studying it privately, playing it in multiple ensembles, and playing music written specifically for it. Guitar was something I always really enjoyed playing, but never something I believed I was good enough at to advertise as a guitarist. Lack of confidence and formal instruction led to me taking my first lessons twelve years after I first picked it up.

With feet in both the worlds of concert and popular music while also not a virtuosic performer or composer, I struggled to define my own identity and voice within these spheres, and there seemed to be few outlets for someone who wasn't planning to teach in the public schools or immediately go into a profession of performance or post-graduate studies. I don't know who I am. Performer? Composer? Scholar? No single label seemed to fit and when introducing myself I would always just say "musician" and that seemed to suffice.

The concerts that I was involved in were always attended by supportive friends, family members, or fellow students looking to complete degree requirements. These were not the people excited to hear this music, people who would excitedly count the days until the first note, who would plan their days around this one event, who would stand in line for hours to get a glimpse of the performers and create cherished memories that would warm their souls.

I was tired of playing music for people who weren't excited to hear it, for people who were only present to support the players.

My voice was not being heard.

As more people approach higher musical education from diverse and non-instrumental backgrounds I constantly wonder if there is space being made for those without formal musical training, who still exhibit high levels of musicianship. Popular music studies are blossoming into an incredibly inclusive and multi-disciplinary field of study, but I found it difficult to find those who had successfully traversed the gap between worlds instead of firmly residing within one side or the other.

While finishing my undergraduate degree in music I pursued an Associate of Science in audio engineering and was exposed to an entirely different paradigm in music education. More emphasis was placed on the knowledge of technology and how to manipulate it in incredibly musical ways. I was taught aural skills that shifted away from harmonic and rhythmic dictation towards the analysis of timbre, the creative reproduction of sound, and detailing of complex aesthetic decisions towards creating final musical products.

Viewing my musical training through this lens was extraordinary. It opened my eyes to an entirely new way of listening and coalescing abstract sonic nuances, and also how they serve the greater whole of the music itself—specifically of recordings which have come to dominate the way we interact with music.

As exacerbated by the COVID-19 pandemic, musicians are now expected to be audio engineers. Students must prepare and submit recordings of audition materials, portfolios of their compositions, and meet the rising demands of works that include external electronics and amplification. Not only this, but remote collaboration and lessons demand a working knowledge of audio interfaces, compression, microphone selection and placement, and basic signal flow. Now more than ever musicians are directly interfacing with technology and musical equipment, and their list of required skills have expanded to include not only the technical facilities of their instrument, but the technological.

Herein was my problem: I could apply my musical skills to shape phrases, efficiently practice, and analyze the harmonic context of what I was playing but had little knowledge of how to create the sounds I needed to for my given circumstances. These were skills that resided purely within the realm of technology, of amplifiers and pedals and pickups.

There is significant discourse surrounding the equipment used in electric guitar tone production, and hearing guitarists talk about their instrument and related gear I would constantly become lost in a tsunami of abbreviations, numbers, and proper nouns. Floyd Rose? 335? Humbucker? Tubes? Endless discussions over the minutiae of their electronics and supporting accessories were flowing out of the guitarists around me, and I had a hard time believing that any of it was serious. Guitarists are always searching for that one vintage pedal, instrument, or amplifier that will bring them closer to their dream tone, and the actualization of their desired voice.

I thought there was no way that a different set of strings or simply changing one part of a larger system would radically shift the way something sounds, and that this must be entirely psychosomatic. More interesting to me was that these discussions were fairly limited regarding the musician's playing techniques or the composition of music they were performing, something that is of much greater interest to those in higher education.

So why the focus on toys or accessories, and not on musicianship or literature? Could they be related? Does it matter?

These questions had been swimming through my brain in the weeks leading up to my most recent gig: 3 performances of the rock musical "Godspell" produced by a local high school.

Before I got the gig, I had an amplifier that had lots of built-in effects and emulators of other amplifiers, and no pedals or outboard effects. As someone who rarely played out and was perfectly content to practice at home, this setup was perfect! Most of my guitar activities were either for a local church where I played acoustic guitar, or studio recording where I needed very little physical gear because of the swath of virtual signal processors available within my computer.

Once I got confirmation that the part was mine, a brief panic came over me. Surely I had the skills and abilities to play this music, but did I have all the necessary equipment? It was my first time playing for this director and I needed to look as professional as possible when I showed up to the first rehearsal. That meant having pro gear and knowing how to use it! At the time of acceptance, I only had an acoustic guitar and a retro-looking hollow body. Neither were very expensive. My amplifier was held together by various black tapes to cover the shredded cardboard frame. My guitar stayed in tune most of the time so long as I didn't travel too far up the neck.

In my eyes, neither gave off the impression of someone who confidently knew what they were doing.

In my panic to look as professional as possible I made two impulsive purchases: a Fender Stratocaster, and a Line-6 Helix signal processor. I knew nothing about the Stratocaster other than its legendary association with Jimi Hendrix, Eric Clapton, Stevie Ray Vaughan. If it was good enough for them, surely it would work for me. I had no easily controllable effects, so I could either buy individual pedal effects, or all of them at once. The Helix is a controller that has dozens of audio effects along with virtual amplifier and speaker emulations, controlled by foot switches. The guitarist can plug into one box and have amplification, effects, and full control over both all in one place!

I quickly found myself equally in love and overwhelmed with numerous tonal and routing options and drowning in a sea of vernacular and history that I couldn't make sense of. Should I add volume after distortion? Why does moving the chorus effect around change the sound? Should I put reverb before or after the amp? I could apply my higher-education musical training to shaping phrases, counting out passages, and organizing my practice session for peak efficiency but I was never trained to organize gear and how it may shape my overall sound.

In the saxophone world you either played classical styles or jazz styles, and each style had a few name brands to choose from. Easy! If there was a tonal shift or difference in sound between players, it was always mostly attributed to the physicality and maturity of the player, and not necessarily tied to what model horn or reed they were using.

An electric guitar is equipped with a set of electromagnetic transducers that "pick up" the sound of vibrating strings and allow them to be transferred through various signal processors, one or many stages of amplification, and then transmitted through a speaker. Any individual element of this signal chain can be modified including the elements that vibrate the string, the wood and shape of the instrument, the properties of the pickup, which pickup is currently active, the components within the speaker and amplification system, all the way down to the cables and connections that are used to string the parts together.

A typical pedal board is comprised of several electronic boxes that manipulate the incoming guitar sound in any number of ways and can be re-ordered or stacked to achieve the desired timbre. These can be as simple or complex as desired, and are heavily dependent on the context in which they are being used, and the people they are being heard by.

After several days of exploring each page of the user's manual, YouTube videos, and knob-turning I was able to make my first preset sound for the opening number! I spent the months before the show zealously listening to the original recordings of the show, as well as several other covers on YouTube to get a feel for the kind of sounds I should be building. The score was littered with the usual musical notations such as slurs, chord symbols, and rhythms but also included specific timbral references such as "Wet Crunchy Light", "Overdriven", "Twang Slap", "Seagull", and "Chunk".

These words are chosen so they may intuitively inform meaningful relationships between sounds and timbral combinations among experienced musicians. To those not in the know, they are non sequitur gibberish.

The ability to communicate these timbral choices is dominated by references to similar sounds without description and general, subjective definitions of the sounds themselves, transgressing conventional harmonic or musical descriptors. Regardless of genre or ensemble, timbre is communicated through single descriptive words (a director may ask for a brighter, darker, round, or cold sound from their group). Most often this translates to physical changes within the performer such as a closed or open throat, a different tongue position, or a change in air usage and not a change in their equipment such as a mouthpiece change or a new larynx. The increased use of electronic amplification and synergy with acoustic instruments affords us an incredible expanse of tonal options independent of playing techniques or physical changes on the part of the performer.

All the way up to the first rehearsal I was doubting my tonal choices, and my limited knowledge of the amplifier and effect simulators and their related aesthetic characteristics greatly slowed the process. I would loop 30 seconds of the songs at a time and write notes on the guitar tone. Is it clean? Scratchy? Distorted? Could I hear any effects or processing? What kind of amp might best recreate that sound? If the sound changed throughout the song, how should I program the effects to best facilitate that change? This was a long and complicated process that involved several hours of knob turning independent of working on the notes, rhythms and dynamics of the tunes! I was building the car while trying to drive it, and it took me about a month to fully program the entire show.

This was an invaluable learning experience, but I was surprised that while I was nearing completion of degrees in music and audio engineering, I had never encountered coursework in effect signal flow or amplification technology beyond basic descriptions. This was an entirely separate skillset that contemporary guitarists were expected to have on top of their technical and expressive facilities.

The show called for at least two guitarists, and the other man hired for the job was Professor Clint Randles. While attending the University of South Florida I knew that he was around but had only briefly met them once during my application process. In between rehearsals we would talk about our guitar setups and routing choices, audio technology, music education, and the combination of all three. Nearing the end of my undergraduate degree, he seemed like an ideal mentor for me. Like me, Dr. Randles had feet in both worlds and was a strong advocate for the integration of technology and popular music into musical education.

After the shows had completed, I approached them with a list of potential independent study ideas and we both resonated around one proposal in particular: an aural/technological skills class for guitarists.

I wanted to codify and strengthen my process for preparing guitar tones and timbres for live performances, and knew that there must be other people who would similarly struggle with articulating their wants and needs through their equipment. These were people struggling with their identities, unable to take the first steps of imitation before they transform into their true and novel selves.

Of course, I had no idea how to actually **do** any of this.

I had never made any kind of class, didn't know any detailed history or information regarding guitar equipment, how to analyze timbre, nor did I have any experience teaching a class. I would have to learn everything there was to know about guitar tone, guitar amplifiers, notable players and histories, and relearn how to listen to the music I've been hearing my entire life.

I was back to building the car while I was driving it!

I met for about an hour each week with Dr. Randles as I organized my research into modules, discussed ideas and readings I had found, and talked about potential applications or outlets for my project. Each week I compiled progress and thoughts into a general journal which we have converted into this Autoethnography. We have applied to present at the annual NAMM (National Association of Music Merchants) convention, as well as the International Society for Music Education (ISME) conference held virtually from Brisbane, Australia.

I wrote and conducted literature reviews while working a full-time job, leading a worship ensemble, and finishing my degree as well as trying to fit in the truly important things in life: my fiancée and two cats.

Through the course of the semester, I built an outline for a 16-module online course that would walk students through the history of electric guitar tone from its earliest inception as an acoustic instrument, the gradual stages of amplification and the introduction of effects up to the 1990s. The course would be a semester-long discussion of tone, timbre, and the effects these have on performers, listeners, and popular music culture. It would demonstrate the impact that the music industry has had on the creation of instruments, technology, and performer identities. By understanding where tone has originated and how it is perceived and implemented, students will be able to recreate guitar timbre for genre-specific contexts, as well as use descriptive aural terms to better refine their sounds. The course would be set up in a blended format, meeting once a week with a heavy amount of information placed within an online course shell. The in-person meetings would primarily be used for live discussions, demonstrations, and as lab experience manipulating various technologies and analyzing their effects.

Focused audio examples from across contemporary musical literature will be discussed and analyzed, and students will be required to talk and analyze other examples from their own musical experiences. Numerous online resources will be utilized to supplement readings from academic journals. This format is inspired by the series of Critical Listening classes offered by St. Petersburg College's Music Industry and Recording Arts (MIRA) program, which tasks students with critically analyzing production techniques within contemporary recordings, and presenting their findings for the class.

This course can serve as a primer for music educators who are more than likely going to be responsible for or interested in popular music and bringing that to their schools, popular music musicians with interest in music production techniques. Before working on this project, I had no idea that there was a burgeoning community of scholarship focusing on timbral and tone analysis within popular music, a world I had been unknowingly searching for the last few years in academia. This appears to be a field that is continuously growing, and popular music programs and curriculums are becoming more and more prevalent across the world. Maybe there is a place for me after all.

To find my voice, all it took was one person who shared a common interest and a genuine passion for student success. Through the investigation of how guitarists manipulate technology to create their own voice I was able to find my own. I am a musician, popular music researcher, and music education scholar.

ANALYSIS: LEARNING FROM A1'S JOURNEY (A2)

A1's journey as a musician who became interested in TGT out of a real-life need to work as a professional musician mirrors the journey of many undergraduate music majors who are looking to make a transition from being a student to being a musician who can live and survive in the real world (Bennett, 2009). I was a part of the College Music Society's GenNext initiative where higher education faculty in music were invited to attend a summer session where they interacted with music industry representatives around topics that could mutually benefit both higher education music and the industry. I met the CEO of Martin Guitars and Gibson Guitars across the two-day conference. I made connections to upstart entrepreneurs that I have maintained relationships with. Topics that were discussed over the course of the two days have influenced a number of my teaching engagements, including my independent study with A1.

TGT is a source of growth within the music industry. It is surrounded by a community of people who are passionate about innovating with tone and creating products that not only accomplish the sonic requirements of practicing musicians, but also exemplify beauty in design and artistic form. YouTube is full of zealous practitioners (Waldron, 2013a, 2013b), knowledgeable experts, and musical salespeople for these products. As A1 reveals in the preceding autoethnography, this world is too infrequently concealed from music students who might benefit greatly from knowing about TGT. Music industry and music in higher education would both be better served by a closer working relationship, as CMS's GenNext initiative has demonstrated (Roads, 1996; Sachs, 2012).

It is important to note here that a majority of the independent study chronicled here occurred online. The literature on the benefits of online learning in music and music education is somewhat extensive. Society benefits greatly from online music-making experiences. This point was extended and amplified during the COVID-19 pandemic. The authors met in a gig that immediately followed the pandemic and was significant in being the first time that both performed in public in a very long time. Musical excellence and a mutual desire to recreate the unique sounds of the world of electric guitar brought us together and saw us through this research project (Butler, 2018).

A1's involvement in the MIRA program at his university primed him to engage with A2 around creating a course for teaching aspects of TGT at St. Petersburg College. The two authors discussed practical aspects of TGT in their weekly meetings while exploring autoethnography as a way to connect the worlds of practice to research without diluting the richness of their discussions (Adams, Jones, & Ellis, 2022). A1 was tasked with keeping a weekly journal and then at the end of the semester distilling his work into a 2,000 form that could be then used for research purposes. Both researchers hope that the primary findings of this work can be used to frame future work at the intersection of higher education music and the music industry where TGT are concerned.

IN WHAT WAYS CAN TGT BE INTRODUCED TO ALL UNDERGRADUATE MUSIC STUDENTS?

Tone, gear, and timbre are a part of the vocabulary of all musicians. The practical/musical world of guitarists is full of specific gear that is created and employed by musicians to achieve specific tonal outcomes. Terms like “muddy” . . . “choppy” . . . “thin” . . . “thick” . . . “overdriven” . . . “fat” . . . and many, many, more are used to describe the timbre of musical sounds (Agus et al., 2012). What guitarists do with their tone can be utilized across the music curriculum to help all musicians consider how the things that they do relate and intersect with the tonal world of the music industry. In both live performance and recording applications, TGT can be discussed and applied to practice in ways that will extend and grow how these things inform the music industry. TGT is very important to practicing guitarists. There is room to grow it as an important and necessary component of the lives of all musicians and students of music.

WHAT ASPECTS OF TGT SHOULD MUSIC TEACHERS BE CONCERNED WITH?

A1 would have benefitted greatly from a discussion of TGT as it relates to saxophone in his training to be a professional musician. Topics like how to make a saxophone sound unique by employing TGT strategies in recording, how to employ unique micing in live performance, and how to talk about timbre more than a surface understanding would have helped him better prepare for the reality that he was faced with upon graduation. He discovered this world through guitar performance, in a back door sort of way. He really felt that his discoveries should have been more central to his education in music. The music industry to full of companies like JHS, Earthquaker Devices, Strymon, Eventide, TC Electronic, and Boss who produce products that extend the tonal qualities and therefore the sonic reach of the electric guitar. There is a lot of potential for these technologies to do the same in a diverse variety of musical settings.

SUGGESTIONS FOR FURTHER RESEARCH

Understanding TGT and what it means for music education, higher education music, and the music industry is an area of potential growth in the literature. New and relatively underexamined areas of the discourse can benefit from autoethnographical explorations (Adams, Jones, & Ellis, 2022) as we try to understand where to direct our research efforts. Music as an activity that human beings engage in has a long history of technological advancements that parallel the recording industry. Live performance technology in TGT seems to parallel the development of innovative TGT in the studio. The path in many cases starts with unique strategies for innovative TGT in the studio, that have to somehow be recreated during live performance, and therefore require new technologies to be created. The music industry produces these technological advances to meet the growing needs of the musicians who utilize them.

Stories of professional producers employing unique strategies to capture innovative timbres might provide a way for researchers to begin to understand the root of specific tonal innovations. In some cases, understanding where specific TGT originated is educative to all students of music. Knowing how TGT was developed may in some cases inspire others to try their hand in developing or extending technology in new ways. Stories of how teachers teach their students about tone may help the greater music education community identify strategies that are scalable to the greater music education community. Stories about how specific TGT was created by innovators in the music industry may help inform further innovation in product development. It might also better inform how specific TGT might best be taught.

Studies that examine teachers current practice in the teaching of TGT aspects would help the research community know where to start with both quantitative and qualitative approaches to research around the use of TGT in musical practice, the development of TGT by the music industry, and study of a pedagogy for introducing TGT topics in music education. Quality resource materials written by music educators need to be developed that situate music teachers as knowledgeable insiders into the world of music production and recording arts (Randles, 2022), the world of original music creation where TGT is an important aspect (Randles, 2024) of the creative process, and the related world of engineering quality recordings based on an insider knowledge of TGT in DAW and live performance settings. Much work needs to be done in this important area of discourse. Both higher education music and the music industry itself stand to benefit from more closely aligning work being done in the world of TGT in research and practice. The relationship is symbiotic, complex, and worth much more time, energy, and rigorous examination.

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BIOGRAPHIES

JOSEP MANUEL BERENGUER

Graduate in Medicine and Surgery at the UAB (1978), Master in Music Therapy at the UB (1979), Master in Clinical Psychology at the UB (1980), Master in Electroacoustic Music at the IIME/IUT (Bourges, 1984), Josep Manuel Berenguer is a composer and guitarist. Director of the Orquestra del Caos and intermedia artist, founder of Côclea with Clara Garí, collaborator of the International Institute of Electroacoustic Music of Bourges (France), he was the designer and first responsible of the Laboratori de So i Música del CIEJ-La Caixa. Fundació, as well as professor of Electroacoustic Music at the Conservatori de Bourges. Former president of the Associació de Música Electroacústica d'Espanya and former vice-president of the Fundació d'Artistes Visuals de Catalunya, Josep Manuel Berenguer is currently coordinator and professor of Psychoacoustics and Experimental Music of the Master in Art Sonor of the UB, Honorary President of the CIM/UNESCO International Conference on Electroacoustic Music, member of the International Academy of Electroacoustic Music/Bourges and Phonos Foundation.

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Graduated in Education and Computer Science and then in Musicology from the HfM in Karlsruhe (Germany), Jesús Jara López specializes in music education with computer code. He was coordinator of the fourth international live coding conference ICLC in 2019 and has been director of the "María Dolores Pradera" Municipal School of Music and Dance, where the Digital Sound Creation itinerary is taught. He participated in festivals such as In-Sonora (Madrid), Explora (Bilbao), ENSO (Alicante) and Transmediale (Berlin). He has been a cultural mediator at Medialab Prado and collaborates annually in the organization of the XR section of the LEV Matadero festival and in the European networks and projects in which the festival participates.

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Adolf Murillo has a Ph.D. in education and holds degree in music (Conservatorio Superior, Barcelona); he is also specialist in electronic music and video creation (Universitat Politecnica de València). Currently, he works as Senior Lecturer at the Universidad de València and researcher at the Institute of Creativity and Educational Innovations of the Universidad de Valencia, Spain. His research is related to musical creativity, collaborative creation and learning, contemporary music and digital technologies.

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Petri Kärkkäinen is a freelance sound designer, recordist/editor, and musician, primarily working in film and TV. Currently, he's pursuing an MA in Film Sound Design at Aalto University. He studied music at Kuopio Conservatory and sound design at TAMK and the Academy of Performing Arts in Prague. Kärkkäinen has contributed to over 30 feature films, documentaries, and TV series as a sound mixer and sound effects creator, focusing on foley. He directed music videos, short films, and the documentary Kalevi Suopursu Karaoke Show, which premiered at Oulu Music Video Festival in 2022. Petri has also taught sound design at TAMK and New Theatre Helsinki.

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Pamela Burnard is Professor of Arts, Creativities and Educations at the Faculty of Education, University of Cambridge. She has published widely with 20 books and over 120 articles which advance the theory and practice of multiple creativities across education sectors including early years, primary, secondary, further and higher/further education, through to creative and cultural industries. She is a Fellow of the *Royal Society of Arts* (RSA), Fellow of the *Chartered College of Teaching*, UK and Fellow of the *International Society for the Study of Creativity and Innovation* (ISSCI).

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Pere Vicalet is a composer, conductor, and digital artist renowned for blending acoustic and electronic music. He has led numerous orchestral ensembles and serves as a professor of Music Technology at the Conservatory of Valencia, spearheading many innovative projects. His accolades include the Talento Joven in Culture and the Miguel Hernández Award for his groundbreaking work in interactive music. Vicalet's creations have been featured at festivals such as Ensems and with the ORTVE, distinguished by his eclectic fusion of genres and real-time integration of technology and sensors.

CLINT RANDLES

Clint Randles is Professor of Music Education, Co-Director of Contemporary Commercial Music at the University of South Florida School of Music. Dr. Randles is both an award-winning composer/songwriter and recipient of the 2015 Michael L. Mark Music Research Award for outstanding research by an early career scholar/researcher, issued by the University of Michigan. Randles teaches "Creative Performance Chamber Ensemble" for music education majors and directs the "Holly Drive Collective" for CCM students at the undergraduate level, and "Creativity Conceptions" and "Directed Research" at the graduate level for students in the College of Design, Art & Performance since 2010. He also teaches classes for students with disabilities in a community music outreach sponsored by Arts4All Florida. He is the Chair of the Popular Music SRIG for the National Association for Music Education and the Contemporary Media Committee for the Florida Music Educators Association.

BO GARRARD

Has been working on, underneath, or adjacent to stages for 15 years as a designer, musician, technician, and composer. When they are not designing and mixing theatrical works they are performing on stage with local ensembles in Tampa, Florida. At the time of the writing of this chapter, Bo was an undergraduate student at the University of South Florida School of Music, where he met Dr. Randles.

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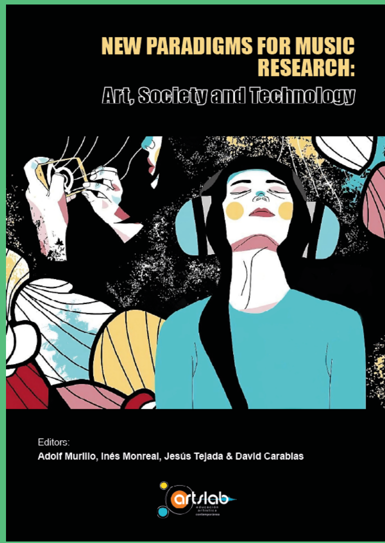

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