Teacher education is a deeply pedagogical process rooted in values, ethics, and the social purpose of schooling. Globally, it sits at the core of educational quality and fairness, as research in comparative and international education demonstrates: the training of teachers directly influences students' learning chances, social inclusion, and the democratic aims of schools. Teachers are not simply transmitters of curricula, but active professionals whose convictions, reflective skills, and ability to manage the complexities of classroom life give shape and substance to the educational experience itself.

The pedagogical dimension of teacher education frames teaching as a relational, context-aware, and ethically grounded profession rather than just a set of procedural skills. From a research perspective, this demands robust research methodologies that can critically examine the complex realities of schools and inform evidence-based policies. Equally important is the connection between theory and practice, which helps to bridge the persistent gap between universities and schools.

The contributions gathered in this volume reflect the richness and diversity of experiences showcased during the ATEE Spring Conference 2024, held at the University of Bergamo from May 29 to June 1, 2024. The volume presents 70 selected papers out of more than 300 presented by researchers representing over 40 countries.

This broad spectrum of studies highlights promising directions that can inspire renewed inquiry and concrete proposals aimed at improving contemporary educational systems.

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May 29th – June 1st, 2024
S. Agostino, Bergamo

Edited by Nicole Bianquin and Francesco Magni

UNIVERSITÀ DEGLI STUDI DI BERGAMO

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ATEE
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BOOK OF PROCEEDINGS

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POSTER SESSION

The contributions published in this book of proceedings have been evaluated through a double-blind peer review process. We would like to thank the members of the Scientific Committee, as well as the many other professors, researchers and experts who agreed to act as reviewers.

Music as an inclusive tool for promoting a sustainable Culture

Francesca Finestrone, *University of Foggia,* francesca.finestrone@unifg.it

Abstract

This research project, conducted in a middle school, investigates the outcomes of implementing Technology Enhanced Active Learning (TEAL) using a wearable bio-feedback tool that converts plant electrical variations into musical notes. The aim is to strengthen students' connection with nature and encourage pro-environmental behaviors. Participants were divided into control and experimental groups, with pre- and post-intervention questionnaires guiding the analysis. The study emphasizes inclusive learning through Orff music and accessible digital tools, benefiting students with and without formal musical training. The research explores the role of music in fostering ecological literacy and biophilic responses, examining how music-making with nature can enhance creativity, emotional well-being, and environmental awareness.

Keywords: nature; music; inclusion; well-being; education.

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1. Introduction

In an era where global sustainability challenges demand innovative approaches, education emerges as a powerful tool to foster ecological awareness and action. Among various educational strategies, music presents a unique and underexplored avenue to bridge the gap between human experiences and environmental consciousness. As a universal language capable of transcending cultural, linguistic, and social barriers, music has the potential to evoke emotional responses, foster creativity, and inspire a sense of interconnectedness with the natural world. This study investigates how music, integrated with technology and pedagogy, can serve as an inclusive medium for promoting sustainable culture within educational contexts.

Music education, historically revered for its cultural and emotional significance (Varadi, 2022), often operates on the periphery of formal educational curricula. Despite its potential to contribute to holistic human development, music is frequently sidelined in favor of subjects perceived as more directly relevant to academic or professional success. However, its intrinsic qualities—emotional resonance, aesthetic appeal, and collaborative nature—make it an ideal candidate for addressing broader societal goals (Rabinowitch, 2020), such as fostering environmental stewardship. Recent pedagogical advancements (Ivanaj & Ivanaj, 2010; Trott, Even & Frame, 2020) advocate for interdisciplinary approaches that integrate arts, sciences, and technology, thus providing fertile ground for exploring music's role in sustainability education.

The concept of sustainability encompasses four interconnected dimensions: environmental, social, educational and economic (Biasutti & Frate, 2017). However, achieving sustainability is as much a cultural and emotional challenge as it is a scientific or technical one. Education for sustainable development (ESD) emphasizes the importance of equipping individuals with the knowledge, skills, values, and attitudes necessary to contribute to a sustainable future. In this context, music can act as a catalyst for emotional engagement and behavioral change, fostering a deep and enduring connection to the natural world.

The growing field of ecomusicology offers insights into how music can reflect and influence environmental values (Allen, Titon & Von Glahn, 2014; Gambirasio, 2022). By exploring the intersection of music, culture, and ecology, ecomusicology highlights the potential of music to inspire action and deepen understanding of ecological issues. Building on this foundation, the current study examines how technology-enhanced music education can nurture a biophilic response—a natural affinity for living systems—and foster ecological literacy among students.

A critical dimension of this research lies in its focus on inclusivity. Traditional educational models often exclude or marginalize students with diverse needs, abilities, or backgrounds. Inclusive education, by contrast, seeks to create learning environments where all students can participate fully and meaningfully. Music, with its universal appeal and adaptability, offers a powerful means to achieve inclusivity, particularly when combined with digital tools that enhance accessibility. The use of wearable biofeedback devices, such as the Plants Play technology employed in this study, represents an innovative approach to bridging the gap between nature, music, and education. By translating the bioelectrical signals of plants into musical notes, these devices provide students with a sensory and interactive experience of the natural world, fostering curiosity and emotional engagement.

2. Music education in the Italian school

History bears witness to how the Italian peninsula has been, and continues to be, the birthplace of many of the most influential musicians and composers in the international music scene. Consider, for instance, the Renaissance, during which luminaries such as Gioachino Rossini, Gaetano Donizetti, Giuseppe Verdi, and Giacomo Puccini emerged, eventually leading to modern figures like Ennio Morricone. This phenomenon can be explained by various sociocultural characteristics, such as a rich cultural tradition that provided fertile ground for the development of new musical forms and styles, as well as the establishment of infrastructures that allowed music's evocative power to flourish.

A key driving force behind the composition of musical works was not only the emotions rooted in the artists' souls but also their social status within the broader society. It is no exaggeration to say that music has historically served as one of the primary forms of both emotional and cultural education for various peoples since antiquity. Yet, despite the significant role music has played—and continues to play—on the Italian peninsula, musical education has struggled to gain formal recognition as an integral discipline within structured learning environments.

In the context of music education, It is essential to distinguish between *music education* and *music tuition*, since these two areas, although interconnected, have different pedagogical objectives and teaching strategies depending on the educational context in which they are applied.

The term *music education* refers to music education in a broad sense, often integrated into school curricula and aimed at providing students with a general understanding of music. This includes the acquisition of theoretical (music reading and writing), historical (evolution of music and its styles), cultural and creative (listening, composition, improvisation) skills (Jääskeläinen, 2021). School music education aims to develop an artistic sensibility and basic musical knowledge accessible to all students, regardless of their level of instrumental or vocal ability.

On the other hand, *music tuition* refers to the specific teaching of a musical instrument or singing, often in individual or small group settings. This type of education is generally offered in conservatories, music schools and secondary music schools, or through private lessons and focuses on developing technical and interpretive skills. The main objectives include learning performance techniques, practice and performance, adapted to the needs of each student according to their level and artistic aspirations.

In this sense, the first evidence of music education in Italy can be traced back to 1885 when, through a circular issued by the Ministry of Public Education of the Kingdom of Italy, Minister Baccelli included singing among the optional school subjects. From that point onward, music education began to take on a marginal role in the Italian school system.

Later, the Royal Decree no. 2185 of 1 October 1923 further addressed music education, stating in Article 7 that:

"The preparatory grade education has a recreational character and aims to discipline the first manifestations of a child's intelligence and character. It includes, in addition to the simplest prayers: Singing and musical listening; [...]"

This decree formally introduced music education in nursery and primary schools across the Kingdom of Italy, while excluding it from secondary schools, both lower and upper levels. An exception was made for teacher training colleges, where two hours were dedicated to “elements of music and choral singing,” and for girls’ high schools and vocational training schools, where choral singing was also included (R.D. 2185/1923).

A pivotal step in integrating music education into Italian schools was Law 1859/62, which made middle school (secondary school) compulsory and included “artistic education” in the curriculum. However, the content of this subject was not specified until the passage of Law no. 517/1977, one of the most significant pieces of legislation in Italian educational history. This law introduced profound and lasting innovations to the education system, including greater emphasis on artistic and expressive subjects such as music education.

The 1977 law had a significant impact on music education by introducing integrative and workshop-based activities. Music was recognised as a fundamental component of school education, not only for its educational value but also for its contribution to the development of students' expressive, creative, and relational skills, especially for special needs students (Darrow, 2003). Through the hands-on approach promoted by the law, music education became more practical and experiential, encouraging direct student participation through activities like singing and playing musical instruments.

In 1979, the new curricula, outlined in the Ministerial Decree of 9 February 1979, introduced specific guidelines for music education, which was allocated two hours per week. These guidelines were noteworthy for their focus on content tailored to students’ needs and the interdisciplinary approach to music as its "profound essence" (M.D, 1979).

It would take another thirty years to see a renewal of primary school curricula. In fact, with the so-called “Moratti Reform” (Law 53/2003), music education and music tuition were given a more

prominent role through the establishment of specialised music high schools (licei musicali). The Moratti Reform aimed to modernise and restructure the Italian education system, emphasising school autonomy and the enhancement of students' individual talents. It granted music education greater visibility within school curricula, recognising its potential to stimulate cognitive, emotional, and social development. However, despite its recognition, the reform did not bring substantial innovation to music as a core subject. Instead, it primarily underlined the need for stable music instruction without necessarily expanding its scope.
Conversely, the Gelmini Reform (2008) marked a step back for music education. By reorganising the school system, it reduced the hours allocated to music instruction in secondary schools. In particular, music education in lower secondary schools (scuola secondaria di I grado) became optional, undermining its previously established role.
Following the "Moratti Reform," the R.P.D. No. 89 of 2010 further defined the organisational framework of musical high schools (licei musicali).
Article 7 of this decree specifies that musical and choreutic high schools aim to provide students with a balanced and comprehensive cultural and musical education. The article outlines that the curriculum includes both theoretical and practical music studies, encompassing the learning of multiple instruments, composition, analysis, music history, and ensemble practice. This structure enables students to acquire specific competencies and prepares them for advanced studies at university or conservatory level.
Additionally, Article 7, paragraph 5, of the R.P.D. establishes that the annual schedule of mandatory activities and lessons for all students totals 594 hours in the first two years, the second two years, and the final year, corresponding to 18 weekly hours. For each of the musical and choreutic sections, an additional 462 hours per year are included during the same periods, equating to an average of 14 weekly hours.
Despite the detailed regulations provided by R.P.D. No. 89/2010, the penalising situation for music education introduced by the “Gelmini Reform” persisted until the enactment of Legislative Decree No. 60 of 2017. This decree introduced the possibility for lower secondary schools (scuole secondarie di primo grado) to establish music-focused pathways within their regular sections. These pathways were prioritised for groups of students, in alignment with the school’s Three-Year Educational Offer Plan (Piano Triennale dell'Offerta Formativa, PTOF). This framework was later consolidated by the Interministerial Decree No. 176 of 1 July 2022 (M.D. 176/2022).
The aforementioned decree grants each educational institution the ability to create a music-focused pathway, subject to authorisation by the Regional Education Office (Ufficio Scolastico Regionale, USR). These new music pathways have become an integral part of the schools’ PTOF and aim to provide students with a comprehensive education in musical language, combining theoretical, practical, cultural, and instrumental instruction. The inclusion of musical instruments is treated as a component of a personalised school timetable and influences the validity of the school year, as well as promotion to the next grade and eligibility for final State exams.
As previously mentioned, the establishment of music-focused pathways depends on the acquisition of suitable facilities and equipment to ensure lessons on musical instruments can take place. These include individual and group instruction, music theory and reading lessons, and ensemble music practice. Activities within these pathways occur as additional hours beyond the regular school timetable.
In conclusion, music education in Italy has followed a long and challenging trajectory, reflecting both the cultural richness of the peninsula and the structural and political difficulties of fully integrating music into school curricula. Despite significant progress introduced by legislation such as Law No. 517/1977, the Moratti Reform of 2003, and Legislative Decree No. 60/2017, challenges remain concerning resource availability, teacher training, and the full recognition of music as a core discipline.
However, with the establishment of music-focused pathways and the increased autonomy of schools in designing a more diverse educational offer, a new phase has begun. If adequately supported, this phase has the potential to make music a central pillar of the educational system, fostering culturally aware and creatively expressive citizens.

In conclusion, the growing interest in music education has led to an increase in scientific research on the subject. Over the following paragraphs, a pilot study on the 'Green Music' research protocol will be presented. The goal of this protocol is to integrate science, art, and technology in order to foster a genuine connection with the natural world, aligning with the objectives of the 2030 Agenda for Sustainable Development, particularly those focused on promoting environmental sustainability and quality education (Goals 4-13).

3. Music in Environmental Education (EE)

During the investigation of major research databases, including the analysis of academic, professional, and gray literature, a limited number of articles were found that explore the role of music as a tool for communication and raising environmental awareness. Despite the scarcity of available studies, several methodological approaches and avenues for advancing this research have been identified.

The purpose of this study is to explore not only the potential of music as an art form but also as a powerful tool for raising environmental awareness and promoting greater engagement with sustainability, leveraging its nature as a universal language and an accessible and inclusive medium. Music, through its capacity to evoke emotional responses, can serve as a catalyst for creating connections between humans and the natural world. While the dichotomy between humans and nature is scientifically and physiologically inaccurate—since humans are an integral part of the ecosystem—such a separation is still perceived as a reality by contemporary society (Adams & Beauchamp, 2019; Orr, 2020). This phenomenon of alienation from nature has been confirmed in various studies, including those by Kaplan (1989), which highlight the importance of direct experiences with the natural environment in fostering an ecological connection.

The increasing disconnection of children from nature has also been defined as a "nature deficit" (Louv, 2011; White, 2022), with significant implications for the development of their biophilia and naturalistic intelligence (Wilson, 1984). Indeed, the reduced exposure to the natural environment, particularly in early childhood, has devastating effects on the development of pro-environmental skills, as suggested by Barbiero and Berto (2021). Pyle (2003) spoke of the "extinction of experience" to describe the progressive lack of opportunities for direct interaction with nature, a phenomenon that diminishes both the quality and quantity of such formative experiences.

Before industrialization, humans were immersed in natural soundscapes, which represented an important aesthetic and communicative dimension of daily life (Schafer, 1994). With modernization and industrialization, this connection gradually weakened as nature became increasingly regarded as a resource to exploit in the production process, as noted by Gergen (2015).

However, music can serve as a powerful tool for re-establishing this connection, especially when integrated into educational approaches that promote direct interaction with the natural environment (Higgins & Nicol, 2013).

Educators and musicians could collaborate to create music-based educational programs that strengthen students' emotional bonds with the natural world. Recent studies suggest that integrating music and environmental education could stimulate greater pro-environmental engagement, transforming musical experiences into effective interventions for ecological awareness and education (Boyce-Tillman, 2020). Specifically, music can act as an educational tool to enhance sensory and aesthetic experiences, promoting a sense of belonging and motivating actions to protect the environment, as highlighted by Kinker (2021) and Turnbull (2018).

Attachment to places and people, concepts widely discussed in attachment theory (Bowlby, 1969), plays a fundamental role in forming an emotional connection with the environment, which in turn motivates the adoption of pro-environmental behaviors. Recent research suggests that music, as a tool for emotional expression, can serve as a catalyst for developing a positive attachment to nature, especially when integrated into interdisciplinary educational experiences that foster mindful listening and direct interaction with natural environments (Turner & Freedman, 2004; Sunderlal, 2017).

Including music in environmental education not only enriches students' aesthetic experience but also promotes greater ecological awareness, allowing them to become more responsible and proactive citizens in the context of a global ecological crisis (Allen, 2012). Recent research indicates that skills developed through music—such as collaboration, creativity, and environmental awareness—are transversal and applicable not only within the academic curriculum but also in students' daily lives, enhancing their ability to listen, understand, and engage with ecological issues (Tojeiro-Pérez & Gillanders, 2024; Turner & Freedman, 2004).

4. A pilot study

Addressing the environmental issue is not a simple matter, especially when it is associated with negative elements and catastrophic perspectives. The educational action of raising awareness about promoting well-being and protecting natural heritage is often aimed at providing behavioral rules and knowledge related to the environmental phenomena taking place. Although having an ethical code of conduct is important, it is not sufficient in terms of educational and formative outcomes; on the contrary, it could risk exacerbating the detachment from nature that we have discussed in the previous paragraphs, creating an image of Nature as a wicked mother, hostile to humans and full of dangers. So, some questions arise spontaneously: how can we protect something that is perceived as something separate from ourselves? How can we protect something for which we do not feel *sympathy*? In the pilot study detailed in the following paragraph, an attempt will be made to answer these questions using an interdisciplinary approach, aimed at first eliciting an emotional response from the participants, which is essential for (re)building the connection with Nature.

4.1 Introduction and Objectives

In a time when disconnection from natural dynamics represents a significant socio-educational challenge, the "Green Music" protocol emerges as an innovative attempt to foster a deeper bond between young people and nature. The pilot study, conducted at the "D. Alighieri" lower secondary school in Modugno (BA), aimed to evaluate the operational feasibility and preliminary impact of an interdisciplinary educational intervention. The research explored whether and how contact with the natural world, mediated by music as a universal language and biofeedback technology, could enhance emotional and cognitive connections with nature, particularly within school settings.
Specifically, the study investigated how we can promote ESD (Education for Sustainable development) through the use of musical learning and strategies.
Innovative methodologies have the potential to overcome the limitations of traditional teaching practices, opening new perspectives in learning. The use of biofeedback sonification through the Plants Play device is not just a tool for creating immersive experiences but also a bridge between emotions, knowledge, and creativity, transforming the way we engage with learning.
The effects of the proposed activities on the sense of belonging and interconnectedness with the natural world, measured using the validated Connectedness to Nature Scale – children (CNS-ch).

4.2 Tools and Methodology

The cornerstone of the protocol was the use of the Plants Play device, which translates plants' bioelectrical signals into musical sounds. This technology, paired with a mobile application, allows users to listen to and record the melodies "produced" by plants in real time, offering a unique sensory window into the natural world. The proposed experiences included the creative use of Orff instruments, Digital Storytelling (DST) activities, guided explorations, and collective reflections, aiming to foster an experiential understanding of ecological dynamics.
The study sample, consisting of 23 students aged 11 (including 11 males and 12 females), was divided into two groups:
Control Group (CG): Followed a traditional environmental education protocol, focused on theoretical and laboratory-based activities for plant species identification.
Experimental Group (EG): Participated in the "Green Music" protocol, characterized by the introduction of music as a privileged mediator in the human-nature relationship.

Both groups completed a multi-phase program, including pre- and post-intervention CNS-ch assessments, cooperative learning activities, and dissemination moments. Digital and technological tools were integrated to stimulate active participation and promote inclusiveness.

4.3 Quantitative Results

Analysis of data from the CNS-ch scale, as shown by Fig.1, showed a 20% increase in average scores for the experimental group, compared to an 8% increase for the control group. Although the improvement did not reach statistical significance, the results suggest a promising trend, indicating that the innovative approach may positively influence the perception of connectedness to nature.
These quantitative findings were supported by observed changes in participants' behaviors and interactions during the activities. Children in the experimental group exhibited greater enthusiasm, curiosity, and engagement, attributing emotional value to the experiences.

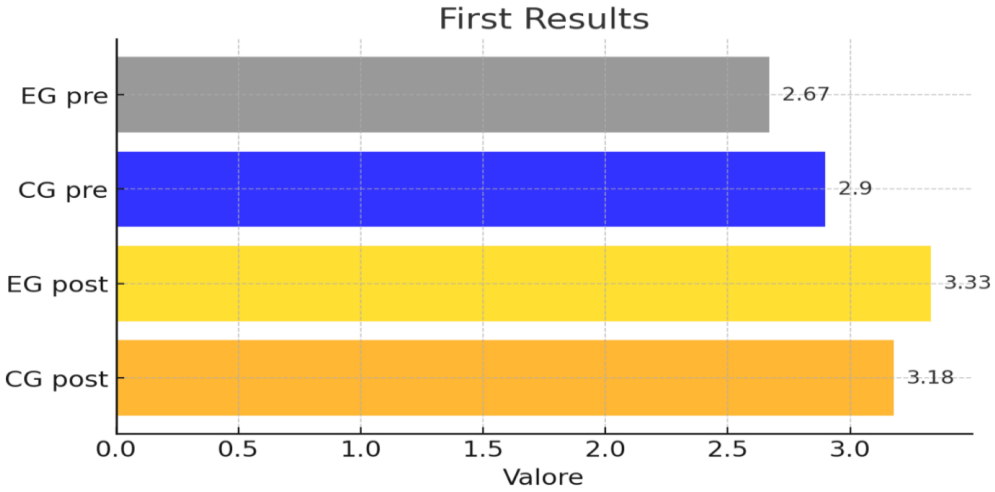

Figure 1: Results obtained following analysis of ex ante and ex post data on the CNS-ch scale.

The analysis of the standard deviation in the two groups shows a reduction in data variability after the intervention, more pronounced in the experimental group than in the control group. In the control group, the standard deviation decreases from 0.773 to 0.442, while in the experimental group it reduces from 1.155 to 0.577. The F-test, which compares the pre- and post-intervention variances, returned a value of 3.07 for the control group and 4.00 for the experimental group. Comparing these values with the critical F-value at a 5% significance level, we observe that in the control group, the variation is not statistically significant, whereas in the experimental group, the reduction in variance is significant. This suggests that the intervention had a stabilizing effect on the data in the experimental group, reducing dispersion in a way that cannot be attributed to chance, whereas in the control group, the change might be due to random or external factors.

4.4 Qualitative Results

Interviews conducted through a thematic analysis, during debriefing provided a rich, complementary perspective to the numerical data. Many children described their contact with nature as a transformative experience, capable of evoking wonder and deep reflections. Some participants perceived the plants' music as a secret language, conveying important messages about the fragility and balance of ecosystems.
The collected testimonies also highlighted how the multisensory approach made the activities more inclusive, allowing all students – regardless of their prior skills or challenges – to actively participate and creatively contribute to the project.

4.5 Discussion

The study demonstrated that the “Green Music” protocol could serve as a valuable tool to innovate educational practices and address the challenges of the global environmental crisis. The combination of immersive experiences and advanced technologies allowed participants to transcend the limitations of traditional teaching methodologies, which often focus solely on theoretical knowledge acquisition.

The use of tools such as Plants Play introduced an element of wonder and surprise, fostering an ecological awareness that was not only rational but deeply emotional. Group activities, such as Digital Storytelling and cooperative learning, also promoted the development of transversal skills, including collaboration, creativity, and empathy.

However, certain limitations must be considered. The small sample size and the specific school context may affect the generalizability of the results. Future studies should scale up the implementation, integrating long-term monitoring tools to assess the sustainability of the observed effects.

4.6 Future Implications

The experience of the “Green Music” protocol offers several insights for the future of environmental education:

Interdisciplinarity: Integrating music, technology, and experiential pedagogy represents an innovative approach to fostering a profound understanding of ecological dynamics.

Inclusivity: The proposed activities can be adapted to diverse educational contexts, ensuring the active participation of all students, including those with special educational needs.

Long-Term Impact: It will be essential to verify whether increased connectedness to nature translates into lasting changes in ecologically sustainable behaviors.

5. Conclusions

The results from the "Green Music" protocol pilot study suggest that music, when integrated into environmental education, can serve as a powerful tool for fostering deeper connections with nature. The results indicate that music can enhance emotional engagement, promote creativity, and encourage a sense of belonging to the natural world, particularly when coupled with innovative technologies like biofeedback. The positive trends observed in the experimental group—though not yet statistically significant—highlight the potential of music as an effective medium for stimulating environmental awareness, empathy, and pro-environmental behaviors.

By bridging the gap between emotional, sensory, and cognitive experiences, the study emphasizes the role of music in breaking traditional boundaries in education, making learning more immersive, inclusive, and impactful. The protocol's success in creating a multisensory, collaborative learning environment offers a promising direction for future educational interventions, where ecological understanding is nurtured not only through theoretical knowledge but also through emotional and experiential engagement.

Future research should build upon these findings by expanding the scope of study, evaluating long-term effects, and assessing how music-based environmental education can lead to sustained changes in behavior. Ultimately, this research contributes to a more holistic approach to environmental education, one that empowers students to not only understand ecological concepts but to feel and act on a deeper, personal connection to the natural world.

Division of paragraphs

The paragraphs were divided equally among the authors. Author Finestrone wrote paragraphs 3 and 4, author Savino wrote paragraphs 1 and 2 while author Palmisano wrote paragraph 5.

Bibliography

Adams, D., & Beauchamp, G. (2019). Spiritual moments making music in nature: A study exploring the experiences of children making music outdoors, surrounded by nature. *International Journal of Children's Spirituality, 24*(3), 260–275.

Allen, A. S. (2012). Ecomusicology: Bridging the sciences, arts, and humanities. In D. R. Gallagher, N. Christensen, & P. Andrews (Eds.), *Environmental leadership: A handbook*. Sage Publications.

Allen, A. S., Titon, J. T., & Von Glahn, D. (2014). Sustainability and sound: Ecomusicology inside and outside the academy. *Music and Politics, 8*(2). https://doi.org/10.3998/mp.9460447.0008.203

Barbiero, G., & Berto, R. (2021). *Introduzione alla biofilia. La relazione con la Natura tra genetica e psicologia*. Carocci Editore.

Biasutti, M., & Frate, S. (2017). A validity and reliability study of the Attitudes Toward Sustainable Development Scale. *Environmental Education Research, 23*(2), 214–230.

Bowlby, J. (1969). *Attachment and loss* (Vol. 1). Random House.

Boyce-Tillman, J. (2020). An ecology of eudaimonia and its implications for music education. In *Eudaimonia* (pp. 71–89). Routledge.

Darrow, A. A. (2003). Dealing with diversity: The inclusion of students with disabilities in music. *Research Studies in Music Education, 21*(1), 45–57.

Gambirasio, L. (2022). Ecomusicology and the potential of music and sound for environmental education. *The Boolean: Snapshots of Doctoral Research at University College Cork*, 9–14.

Gergen, K. J. (2015). From propositions to practice: Pedagogy for life as process. *Education as Social Construction*, 49.

Higgins, P., & Nicol, R. (2013). Outdoor education. In T. G. K. Bryce & W. M. Humes (Eds.), *Scottish education* (4th ed., pp. 620–627). Edinburgh University Press.

Hirnstein, M. (2016). *How to write a bachelor thesis in (APA) style*. Program for universitetspedagogikk, Universitetet i Bergen.

Interministerial Decree No. 176 of July 1, 2022 - Discipline of music-oriented pathways in secondary schools of the first grade.

Ivanaj, V., & Ivanaj, S. (2010). The contribution of interdisciplinary skills to the sustainability of business: When artists, engineers, and managers work together to serve enterprises. In *Global sustainability as a business imperative* (pp. 91–109). Palgrave Macmillan.

Jääskeläinen, T. (2021). Tuition fees, entrance examinations and misconceptions about equity in higher music education. *Nordic Research in Music Education, 2*(1), 4–19.

Kaplan, R. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press.

Kinker, S. M. S. (2021). *Exploring the relationship between nature connectedness and belonging with pro-environmental behavior in Brazilian national parks* [Master's thesis, University of Montana].

Knudson, M. C. (2012). Attachment in adult relationships: A feminist perspective. *Journal of Family Theory & Review, 4*(4), 299–305. https://doi.org/10.1111/j.1756-2589.2012.00141.x

Law No. 240 of December 30, 2010. Norms on the organization of universities, academic personnel and recruitment.

Law No. 1859 of December 31, 1962. Establishment and ordering of the state middle school.

Law No. 517 of August 4, 1977. Regulations on the evaluation of pupils and the abolition of remedial examinations.

Law No. 53 of March 28, 2003. Delegation of powers for general norms on education and vocational education.

Legislative Decree No. 60 of April 13, 2017. Rules on humanistic culture and support for creativity.

Louv, R. (2011). *The nature principle: Human restoration and the end of nature-deficit disorder*. Algonquin Books.

Ministerial Decree, February 9, 1979. Programs, teaching schedules and examination tests for state middle school.

Orr, D. W. (2020). Musicophilia, biophilia, and the human prospect. In *Eudaimonia* (pp. 50–59). Routledge.

Pauwels, L., & Mannay, D. (Eds.). (2019). *The Sage handbook of visual research methods* (2nd ed.). Sage.

Pauwels, L., & Mannay, D. (Eds.). (2011). *The Sage handbook of visual research methods*. Sage.

Pyle, R. M. (2003). Nature matrix: Reconnecting people and nature. *Oryx, 37*(2), 206–214.

Rabinowitch, T. C. (2020). Il potenziale della musica per influenzare il cambiamento sociale. *Musica e Scienza, 3*, 2059204320939772.

Regulation on the revision of the systemic, organizational and didactic structure of high schools. (2008). Law No. 133 of August 6, 2008.

Royal Decree No. 2185 of October 1, 1923. Ordering of school grades and curricula in elementary education.

Schafer, R. M. (1994). *The soundscape: Our sonic environment and the tuning of the world*. Destiny Books.

Sunderlal, S. (2017). Treble in the environment: Incorporating music into environmental education.

Tojeiro-Pérez, L., & Gillanders, C. (2024). (Re)connecting music and ecology. *Science & Education*, 1–30. https://doi.org/10.1007/s11191-024-00414-0

Trott, C. D., Even, T. L., & Frame, S. M. (2020). Merging the arts and sciences for collaborative sustainability action: A methodological framework. *Sustainability Science, 15*(4), 1067–1085.

Turnbull, G. (2004). *We are lost together: Blue Rodeo and the construction of identity* [Doctoral dissertation, National Library of Canada].

Turner, K., & Freedman, B. (2004). Music and environmental studies. *The Journal of Environmental Education, 36*, 45–52.

Váradi, J. (2022). A review of the literature on the relationship of music education to the development of socio-emotional learning. *Sage Open, 12*(1), 21582440211068501. https://doi.org/10.1177/21582440211068501

West, M., & George, C. (1999). Abuse and violence in intimate adult relationships: New perspectives from attachment theory. *Attachment & Human Development, 1*(2), 137–156.

White, K. A. (2022). Impactful digital technology: Connecting with nature in early childhood.

Wilson, E. O. (1984). *Biophilia*. Harvard University Press.

Woodruff, C. C. (2018). Reflections of others and of self: The mirror neuron system's relationship to empathy. In L. Stevens & C. C. Woodruff (Eds.), *The neuroscience of empathy, compassion, and self-compassion* (pp. 157–187). Elsevier Academic Press.