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
Association for Teacher Education in Europe

BOOK OF PROCEEDINGS

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POSTER SESSION

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Nature Connection and Music in Early Education: Insights from the CNS-Ch Scale and TEAL Methods

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Abstract

This study explores the connection between music, technology, and nature through the analysis of results from the CNS-ch scale (Connectedness to Nature), measuring the personal relationship with nature in students aged 6 to 11. Biophilia, humans' innate affinity with nature (Barbiero & Berto, 2016), provides insight into individual and collective well-being, the regenerative potential of nature, and the need for its preservation. Technology-enhanced active learning (TEAL) offers an innovative context to integrate nature connection into education (Hills & Thomas, 2020), surpassing traditional environmental education in Italy. This research highlights the use of technologies converting plants' electrical variance into musical notes, allowing children to improvise with percussion or voice. The goal is to assess children's connection with nature using methodologies leveraging music as a propelling tool (Arbuthnott et al, 2022).

Keywords: nature; TEAL; education.

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1. Introduction

The society we live in, increasingly shaped by urban growth and a growing disconnection from nature, underscores the need to invest in innovative environmental education practices to address modern challenges. This paper highlights the transformative potential of interdisciplinary approaches in education, which combine science, art, and technology to foster a deeper connection with the natural world. These methods emphasize the importance of experiential learning and leverage our innate biophilia to inspire sustainable behaviors and a sense of environmental responsibility. The central idea is to move beyond traditional, didactic learning models that often fail to engender lasting pro-environmental attitudes or behaviors. By adopting experiential and interdisciplinary approaches, educational interventions can promote active engagement with nature, fostering emotional and sensory connections that encourage a more profound ecological awareness. This shift supports the development of environmental literacy and empowers individuals to take meaningful action for the planet. The paper is structured into several sections, each exploring a key element of these educational approaches. The first part examines the intersection of nature, culture, and artistic human expression, analyzing the ways in which our environment influences how we perceive and relate to the world around us. It highlights how cultural and natural elements are interwoven and how this relationship can serve as a foundation for fostering environmental mindfulness. The second section focuses on the Connectedness to Nature Scale for Children (CNS-ch), a standardized self-assessment tool that evaluates how deeply children perceive themselves as part of the natural world. Derived from the original scale for adults by Mayer and McPherson Frantz (2004), the CNS-ch was adapted to capture the cognitive and emotional specificities of younger individuals. This tool underscores the importance of early interventions to build strong connections with nature, showing how such bonds are linked to pro-environmental behaviors and overall well-being. The final section introduces the Technology Enhanced Active Learning (TEAL) model, a student-centered teaching methodology based on Dewey's (1938) principle of "learning by doing." TEAL integrates active, collaborative, and interdisciplinary activities with digital tools, creating immersive learning experiences that encourage critical thinking and problem-solving. Originally designed for STEM disciplines, this methodology has proven effective in fostering engagement and inclusivity in a variety of educational contexts, including environmental education.A significant strength of these approaches is their emphasis on inclusiveness and personalization. By incorporating hands-on outdoor activities and accessible digital tools, these educational models are adaptable to diverse socio-cultural contexts and ensure active participation from all students, regardless of their abilities or prior experiences. This inclusivity promotes equity in learning and broadens the reach of environmental education to a wider audience.

2. Ecomusicology: a convergence of nature, culture, and sound

The intricate relationship between humans and their environment has long been a subject of inquiry across disciplines. From the rhythms of nature influencing ancient rituals to contemporary debates on ecological sustainability, the interplay between the natural world and human expression continues to reveal profound insights. Music, as a universal form of communication and creativity, stands at the crossroads of these explorations, offering unique perspectives on how we perceive, engage with, and impact our surroundings. Within this broader context, the emerging field of ecomusicology provides a lens to examine these interconnections, merging artistic, cultural, and ecological dimensions.
Ecomusicology represents an interdisciplinary field exploring the intersection between music, nature, and culture, investigating the relationships between sounds, environments, and human communities. This approach considers music not only as a cultural product but also as a phenomenon deeply embedded within natural contexts and shaped by environmental dynamics. Recent studies, such as that by Adams and Beauchamp (2021), have demonstrated how the environment profoundly influences musical experiences, transforming them into a medium for connecting with the natural world. For instance, rural settings, with their natural sounds like birdsong or rustling leaves, enrich

musical creation and foster a deeper relationship between individuals and their surrounding environment (Arbuthnott et al, 2022).
The concept of ecomusicology encompasses two main approaches: an analytical one, which studies musical communities with the same holistic perspective ecologists use to observe ecosystems, and an experiential one, which views music as a tool for encountering and understanding the world. The latter approach, central to Gambirasio's (2022) work, emphasizes the importance of listening as a means to connect with others and with the environment, fostering an interdependent understanding of community and ecosystem needs. In this perspective, music becomes not only an expressive medium but also an educational and transformative tool, capable of promoting pro-environmental behaviors.
A crucial aspect of ecomusicology is its connection to the concepts of biophilia and musicophilia. Biophilia, defined by Kellert and Wilson (1995) as an innate tendency to seek connections with the natural world, and musicophilia, understood by Sacks (2014) as a profound attraction to music, share a common denominator: human well-being. Both concepts highlight the importance of emotional and relational experiences in fostering a sense of belonging and harmony with nature. Biophilia, in particular, can be stimulated through pedagogical pathways emphasizing emotional participation, encouraging an evolved and conscious relationship with the natural world.
Beyond its effects on humans, research has begun exploring the interaction between music and other forms of life, such as plants. Studies in plant neurobiology (Shivanna, 2022) reveal that plants not only respond to sound stimuli but also use them to communicate their physiological state and adapt to their environment. Specific sound frequencies, such as those produced during cavitation processes, can provide information about plant stress conditions, suggesting a complex and multifunctional form of communication. These findings expand our understanding of sound-ecosystem interactions, highlighting how sound can serve as a universal language among different forms of life.
This interdisciplinary panorama encourages broader reflection on the need to rethink the relationship between humans and nature. Music, with its unique ability to connect and inspire, can be used as an educational tool to raise awareness about environmental sustainability and the importance of preserving ecosystems. Understanding plants as complex beings with communicative and behavioral capabilities breaks anthropocentric barriers and invites us to recognize our role within the web of life. Ultimately, ecomusicology offers an innovative framework for exploring the interconnections between music, nature, and culture. By integrating diverse disciplines, it promotes a holistic and inclusive vision of the living world, opening new pathways for addressing contemporary environmental and social challenges. This work aims to delve deeper into these interactions, analyzing how music can act as a bridge between humans and the environment, fostering a more harmonious and sustainable relationship with the planet.

3. The Connectedness to Nature Scale - children (CNS-ch).

The Connectedness to Nature Scale for Children (CNS-ch) is a standardized self-assessment tool designed to measure the extent to which children perceive themselves as integral parts of the natural world. This scale, an adaptation of the original CNS by Mayer and McPherson Frantz (2004) for adults, was developed by Berto, Pasini, and Barbiero (2012; 2016) to address the unique cognitive and emotional characteristics of younger populations. The CNS-ch comprises seven items, which aim to assess various dimensions of a child's connection to nature, such as feelings of unity with natural elements, affinity with plants and animals, and the perception of equality between humans and other living beings. Each item is rated on a Likert scale ranging from 0 (“never”) to 4 (“always”), with a cutoff score of 3, which serves as a threshold to indicate a significant level of connectedness.
The adaptation of the CNS to children reflects an increasing recognition of the importance of fostering ecological awareness and emotional connections with the environment during formative years. Research has shown that a strong sense of connectedness to nature in children is associated with a range of positive outcomes, including increased pro-environmental behaviors, enhanced well-being, and improved academic performance in environmental education contexts. For example,

studies employing the CNS-ch have demonstrated that children with higher scores on the scale tend to exhibit greater curiosity about natural phenomena and are more likely to engage in activities that promote environmental sustainability.
In educational settings, the CNS-ch has been employed to evaluate the effectiveness of various interventions aimed at strengthening children's bonds with nature. These findings underscore the potential of innovative educational approaches to deepen children's emotional and cognitive engagement with the natural world.
The CNS-ch's methodological rigor is supported by its psychometric properties, which ensure its reliability and validity as a measurement instrument. The scale's items are carefully worded to capture children's subjective experiences and perceptions, avoiding overly complex or abstract language that might hinder comprehension. This accessibility makes the CNS-ch suitable for diverse educational and cultural contexts, as evidenced by its successful application in studies conducted in various countries and school systems. Additionally, the scale's brevity and simplicity facilitate its integration into broader research protocols without imposing excessive demands on participants or educators.
In recent applications, the CNS-ch has been used to explore children's relationships with nature through quantitative measures, offering insights into their emotional and cognitive connections. While primarily focused on structured assessment, its integration with other methods, such as observational studies, could enhance understanding of how children engage with their natural environments. By integrating qualitative and quantitative approaches, researchers can better understand the multidimensional nature of children's connections to the environment.
Despite its strengths, the CNS-ch is not without limitations. The scale's reliance on self-reported data may introduce biases, such as social desirability or variability in children's interpretations of item wording. To mitigate these issues, researchers often complement CNS-ch data with observational methods or third-party assessments by educators and parents. Furthermore, while the cutoff score of 3 provides a useful benchmark, its applicability across different cultural and environmental contexts requires further validation. Future studies could explore the development of localized versions of the CNS-ch, tailored to reflect specific ecological and cultural characteristics.
The CNS-ch's integration into interdisciplinary research and practice underscores its potential as a tool for promoting environmental literacy and sustainability education. For instance, the scale has been used to evaluate the impact of outdoor learning programs, which emphasize hands-on, experiential engagement with nature. These programs often incorporate activities such as ecological fieldwork, wildlife observation, and creative projects that encourage children to explore their natural surroundings. By quantifying the outcomes of such interventions, the CNS-ch helps educators and policymakers identify effective strategies for fostering environmental stewardship among younger generations.
Technological innovations have further expanded the scope of CNS-ch applications. Digital tools, such as biofeedback devices and interactive platforms, have been used alongside the scale to create immersive learning experiences that enhance children's sensory and emotional connections to nature. For example, the use of portable biofeedback instruments allows students to "listen" to the electrical signals emitted by plants, which are converted into musical notes. This innovative approach not only deepens children's appreciation for the complexity of natural systems but also provides a tangible, multisensory experience that reinforces their connection to the environment. Studies incorporating such technologies have reported significant increases in CNS-ch scores, suggesting that these tools can effectively complement traditional educational methods.
The CNS-ch also plays a vital role in addressing broader societal challenges related to environmental sustainability. By cultivating a strong sense of connectedness to nature among children, educators and researchers can contribute to the development of environmentally responsible behaviors and attitudes that persist into adulthood. This aligns with global initiatives, such as the United Nations Sustainable Development Goals, which emphasize the importance of environmental education in achieving a sustainable future.

4. Technology enhanced active learning (TEAL)

Technology Enhanced Active Learning (TEAL) is a student-centered teaching methodology based on Dewey's "learning by doing" (1938), emphasizing action as a crucial element for fostering meaningful learning. Developed at MIT to address performance issues and dropout rates, TEAL integrates lectures, simulations, and hands-on activities, offering a collaborative and interdisciplinary learning experience (Panzavolta & Cinganotto, 2020). Originally designed for STEM disciplines, it has been progressively adapted to other fields, proving effective in diverse educational contexts (Hassan, Puteh & Sanusi, 2018).

The TEAL model follows four main phases: activation, production, elaboration, and closure. During the activation phase, teachers introduce open-ended tasks or problems to spark curiosity and critical thinking, following the principles of conceptual change (Posner et al., 1982). In the production phase, students apply problem-solving strategies and interdisciplinary approaches, consolidating skills through practical and collaborative work (Wood, Bruner & Ross, 1976). The elaboration phase fosters metacognition, encouraging students to critically reflect on outcomes and integrate feedback (Flavell, 1979; Nicol & Macfarlane-Dick, 2006). Finally, the closure phase supports the transfer of acquired skills to new contexts, aligning with transfer theory (PS-Perkins & Salomon, 1988).

Educational technologies, such as digital platforms and monitoring tools, strengthen collaborative learning, enhance student engagement, and provide immediate and personalized feedback (Dunn & Kennedy, 2019). Despite challenges related to resources and digital competencies, TEAL represents an innovative and sustainable model adaptable to various educational contexts.

At the same time, emotional intelligence plays a fundamental role in fostering meaningful learning. Initially defined by Salovey and Mayer (1990) as the ability to recognize, understand, and use emotions to enhance thinking, it includes competencies such as self-awareness, emotional regulation, and empathy. Goleman (1995) expanded the concept, highlighting how emotional intelligence influences motivation, memory, and decision-making. Neuroscientific studies, such as those by Damasio (1999), show that positive emotions enhance learning by improving memory retention and active participation, whereas negative emotions, like anxiety and stress, can hinder it.

The link between technology, active learning, and emotions is critical for creating enduring educational experiences. Tools such as simulations and virtual reality promote immersive learning, combining cognitive and emotional stimuli to make educational experiences more meaningful (Chaidi, Drigas & Karagiannidis, 2021). When applied to environmental education, these methodologies help develop an authentic connection with nature by integrating practical and emotional experiences.

Environmental education represents a field where TEAL and emotional intelligence can be combined to foster sustainable behaviors. Activities that incorporate tools like biofeedback devices, capable of translating natural signals into music, stimulate curiosity and ecological awareness. These multisensory experiences encourage a deep connection with the environment, inspiring students to protect and value natural heritage.

5. Conclusions

In conclusion, the interdisciplinary approach explored in this chapter underscores the transformative potential of integrating science, art, and technology into environmental education. By moving beyond traditional learning methods and fostering experiential and inclusive practices, such approaches can inspire a deeper connection with the natural world and promote pro-environmental behaviors.

The integration of tools like the Connectedness to Nature Scale for Children (CNS-ch) and methodologies such as Technology Enhanced Active Learning (TEAL) demonstrates how innovative educational frameworks can nurture ecological awareness and emotional engagement. These frameworks empower learners to perceive nature not as a distant or abstract concept but as an interconnected system in which they play an active role.

A key strength of these educational strategies lies in their adaptability and inclusiveness. By accommodating diverse socio-cultural contexts and utilizing accessible technologies, they create equitable learning environments that engage participants of all abilities and backgrounds. This inclusiveness broadens the reach of environmental education and ensures its relevance in addressing the pressing challenges of urbanization and ecological disconnection.
Ultimately, interdisciplinary and experiential educational models provide a powerful pathway for cultivating a profound appreciation for nature and fostering sustainable behaviors. As we face growing environmental challenges, these approaches offer a valuable foundation for shaping a future that is more connected, equitable, and harmonious with 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 the abstract and the author Toto Supervised the entire research and writing process.

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