

**SYNECOLOGICAL LEARNING IN AN URBAN CONTEXT: EFFECTS OF A STRUCTURED NATURE
EDUCATION PROGRAMME ON THE SOCIO-EMOTIONAL WELL-BEING AND COGNITIVE
SKILLS OF PRIMARY SCHOOL CHILDREN**
**APPRENDIMENTO SINECOLOGICO IN CONTESTO URBANO: EFFETTI DI UN PROGRAMMA
STRUTTURATO DI EDUCAZIONE AMBIENTALE SUL BENESSERE SOCIO-EMOTIVO E SULLE
CAPACITÀ COGNITIVE DEI BAMBINI DELLA SCUOLA PRIMARIA**

Fabiola Palmiero¹

**University of Macerata – University of Campania “Luigi Vanvitelli”
f.palmiero@unimc.it**

Maria Giovanna Tafuri

**Pegaso University
mariagiovanna.tafari@unipegaso.it**



Double Blind Peer Review

Palmiero, F., Tafuri, M. G. (2025). Synecological Learning In An Urban Context: Effects Of A Structured Nature Education Programme On The Socio-Emotional Well-Being And Cognitive Skills Of Primary School Children. Italian Journal of Health Education, Sports and Inclusive Didactics, 9(3).

Doi:

<https://doi.org/10.32043/gsd.v9i3.1574>

Copyright notice:

© 2023 this is an open access, peer-reviewed article published by Open Journal System and distributed under the terms of the Creative Commons Attribution 4.0 International, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

gsdjournal.it

ISSN: 2532-3296

ISBN: 978-88-6022-522-1

ABSTRACT

In urban settings with limited green spaces, nature education can promote well-being and cognitive development in children. This study evaluated a structured programme on socio-emotional well-being, cognitive skills and ecological awareness in primary students (8–10). An experimental design with control group, pre/post-test and 3-month follow-up was applied to 204 students. Results show significant gains in self-efficacy, stress reduction, attention and pro-environmental behaviours.

In contesti urbani con pochi spazi verdi, l'educazione alla natura può favorire benessere e sviluppo cognitivo nei bambini. Questo studio ha valutato un programma strutturato su benessere socio-emotivo, capacità cognitive e consapevolezza ecologica in una scuola primaria, con disegno sperimentale, gruppo di controllo, pre/post-test e follow-up a 3 mesi su 204 studenti. I risultati evidenziano miglioramenti in autoefficacia, riduzione dello stress, attenzione e comportamenti pro-ambientali.

KEYWORDS

Outdoor education, nature, primary students

Educazione all'aperto, natura, studenti della scuola primaria

Received 12/09/2025

Accepted 28/10/2025

Published 07/11/2025

¹ The paper is the result of a collaborative effort by the authors. Specifically, Fabiola Palmiero wrote paragraphs 1, 2, 4, 5, and 6, along with all related subsections. Maria Giovanna Tafuri wrote the introduction, paragraph 3, and conclusions.

Introduction

In contemporary society, characterised by accelerating processes in technology, society and education, we are witnessing a phenomenon of progressive disconnection between children and the natural environment. Hartmut Rosa (2015) defines this phenomenon as 'social acceleration', meaning the widespread feeling that time is running faster and faster, with consequences for the quality of everyday experiences, especially those of young people. Hyperstimulation through digital media, urban crowding and the reduction of green spaces contribute to a context in which children spend a significant amount of their time indoors, preferring sedentary activities (Chawla, 2015; Louv, 2016).

Richard Louv (2016) coined the term 'nature deficit disorder' to describe the growing emotional and cognitive disconnect between children and nature, linking this phenomenon to possible repercussions on mental health, concentration and general well-being. Longitudinal and cross-sectional studies confirm that regular contact with natural environments, even urban ones, promotes higher levels of emotional self-regulation, sustained attention and psychological resilience (Berto, 2005; Bratman et al., 2019).

For example, an experiment conducted by Berman, Jonides and Kaplan (2008) showed that short walks in urban parks significantly improve performance on attention tests compared to walks in built environments. Children exposed to natural stimuli show greater resilience to mental stress (restorative effects) and reduced levels of physiological and perceived stress (Stilwell et al., 2017; de Vries et al., 2013).

Nature-based education has emerged as an innovative educational response capable of linking curricular content to the environmental dimension. A systematic review conducted by Beery, Raymond and Kytä (2022) emphasises that outdoor learning, when structured and consistent with school objectives, promotes not only socio-emotional well-being but also the acquisition of cognitive skills such as problem solving and working memory.

Outdoor education and inclusive sports activities can be effective learning tools for children with autism (Morsanuto, Peluso Cassese, Tafuri, & Tafuri, 2023). However, much research in the field is limited to descriptive or qualitative interventions, with small samples and a lack of robust experimental designs (Ernst, 2014). In particular, studies conducted in urban contexts often do not consider systematic integration into the curriculum or adopt a mixed, quantitative and

qualitative approach with standardised measurements such as SDQ, CPT or Digit Span (Rickinson et al., 2004). Furthermore, the concept of situated learning (Lave & Wenger, 1991) and the synecological approach — i.e., attention to the interconnection between environment, peers, teacher and content — are still largely unexplored in school educational practices, although theoretically promising (Capra & Luisi, 2014).

Urban areas, with their high population density and fragmented green spaces, represent both a challenge for access to nature and a privileged terrain for experimenting with transformative educational interventions. Interaction with nature in urban contexts has a particularly significant impact on children who would otherwise be excluded from sensory and formative experiences related to the natural environment (Wells & Lekies, 2006).

For example, the 'Direct Experience Theory' developed by Sobel (2004) highlights how even brief and regular contact with nature — if intense and meaningful — can stimulate a sense of environmental connectedness, promoting ecologically responsible behaviour. In urban school settings, nature can be reintroduced through modifications to the school landscape — educational gardens, micro-nature areas or green pathways — which serve as active learning environments (Dyment & Bell, 2008).

The synecological paradigm, as articulated by Capra and Luisi (2014), is based on the understanding that every living system is intrinsically interconnected: learning is not limited to content, but arises from the dynamic interaction between the environment, individuals and communities. From an educational perspective, this means that nature becomes a co-protagonist in the learning process. In urban school settings, the synecological approach involves designing activities in which nature is integrated into teaching, social and cognitive processes, transforming the relationship with the environment from passive to actively participatory. This approach is in line with the principles of critical environmental education (Sterling, 2001), which aims to develop not only ecological knowledge but also civic awareness and responsibility. In this context, outdoor science workshops, artistic activities using natural materials, and cooperative games become both cognitive and emotional tools. They encourage student empowerment — i.e., the perception of control and capacity for action in one's own context — and foster the development of ecological empathy (Chawla, 2015).

Despite a significant body of theory and some empirical evidence on the benefits of nature-based education, some key gaps remain:

1. Little rigorous experimentation with robust quantitative designs (large sample, control group, repeated measurements).
2. Poor integration into the formal curriculum, especially in densely populated urban contexts.
3. The synecological approach has been little explored in its operational dimension, not just in theory.
4. Limited attention to follow-up to verify the persistence of effects over time. Our study aims to fill this gap by integrating:
 - A mixed experimental design (quantitative and qualitative), with an experimental and control group, pre-test, post-test and follow-up measurements (3 months).
 - An intervention integrated into the daily curriculum, divided into 12 weeks with two weekly sessions in a natural urban setting.
 - An explicitly applied synecological approach, where the environment, peers, teachers and content interact systemically.
 - A comprehensive assessment, including socio-emotional well-being (self-efficacy, stress, empathy), cognitive skills (attention, working memory, problem solving) and ecological awareness.

1. Educational and social implications

The possible outcomes of this study, if confirmed, have two important implications:

A) Educational-didactic: the intervention model can be replicated and adapted to school policies, contributing to a curriculum that is truly integrated with the environment and the school community. The synecological approach can become a methodological paradigm for 21st-century schools, capable of responding to the emotional, cognitive and civic needs of students.

B) Social and environmental: promoting awareness and ecological behaviour in the younger generations is crucial for building responsible and proactive citizens in the protection of the environment. Linking individual well-being with ecological action can generate a virtuous circle of active participation and sustainability.

2. Objectives and hypotheses

The main objective of the study is to assess the impact of a nature education programme integrated into the school curriculum on:

1. Socio-emotional well-being (self-efficacy, reduction of perceived stress, empathy).
2. Cognitive skills (sustained attention, working memory, problem solving).
3. Environmental awareness and behaviour.

3. Method

The study adopted a mixed qualitative-quantitative design with an experimental group and a control group, pre-test, post-test and 3-month follow-up measurements. Groups were assigned randomly at class level.

3.1 Sample

The sample consisted of 204 primary school students (104 females, 100 males), aged between 8 and 10 years ($M = 9.1$; $SD = 0.6$), attending four schools located in urban areas with limited access to green spaces. Selection was voluntary, subject to written authorisation from parents/guardians and approval by the relevant Ethics Committee.

Inclusion criteria:

- Regular attendance at primary school (third, fourth or fifth grade).
- Residence in an urban area with a population density of more than 2,500 inhabitants/km².
- No structured and continuous experience of nature education in the six months prior to the start of the study.
- Ability to participate in all planned activities (assessed by teachers based on school observations).

Exclusion criteria:

- Diagnosis of severe neurological or cognitive disorders that may interfere with cognitive measurements.
- Physical conditions or motor limitations that prevent participation in outdoor activities.
- Absence from more than 20% of scheduled sessions.

The stratification of the sample ensured a balance in terms of gender and socioeconomic status, the latter measured using the *Family Affluence Scale* (Currie et al., 2012).

The total sample of 204 primary school students (aged 8-10) was divided into two groups by randomisation at class level, ensuring gender and socioeconomic balance. The classes were assigned to:

- Experimental group (n = 102): followed the structured nature education programme integrated into the school curriculum;
- Control group (n = 102): continued normal school activities without specific nature-related interventions or structured outdoor activities.

4. Intervention

The experimental programme was structured over a 12-week period, with two weekly sessions lasting 90 minutes each. The activities took place in urban natural environments, such as public parks and school gardens, to encourage direct and concrete contact with nature, a central element of the synecological approach adopted.

The sessions included different types of activities designed to stimulate cognitive, emotional and social skills:

- Outdoor science workshops: participants made systematic observations of local ecosystems, collecting data on flora, fauna and environmental conditions. These workshops included measuring and recording variables such as temperature, humidity and species types, with the aim of developing scientific observation skills and empirical methods. Systematic observations of urban ecosystems and the collection of environmental data are based on evidence that practical and authentic activities in natural contexts stimulate scientific thinking, inductive reasoning and curiosity (Beery et al., 2022; Rickinson et al., 2004). Studies by Louv (2016) and

Berto (2005) show that direct interaction with nature improves attention and motivation to study.

- Collaborative problem solving: concrete ecological challenges were proposed to be solved in groups, such as designing solutions for reducing environmental impact in urban contexts or simulating environmental redevelopment interventions. This phase aimed to enhance cooperative work, critical thinking and the ability to apply scientific knowledge creatively. Group ecological challenges are based on social constructivism (Vygotsky, 1978) and situated learning (Lave & Wenger, 1991), where cooperation and real-life context increase the significance of learning. Bratman et al. (2019) confirm that active engagement in natural environments strengthens executive functions.
- Artistic activities inspired by nature: through drawing, photography and storytelling, participants explored expressive ways to recount their experiences during outdoor activities, encouraging integration between the cognitive and emotional dimensions and promoting personal reflection on their relationship with the environment. Creative experiences that translate contact with the environment into artistic language encourage emotional reprocessing and an affective connection with nature (Sobel, 2004; Chawla, 2015). In an outdoor context, the arts act as a catalyst for memory and reflection (Dyment & Bell, 2008).
- Cooperative games: playful exercises and group dynamics have been used to strengthen empathy, mutual trust and collaboration skills, which are considered fundamental for the success of collective activities and socio-emotional development. The literature highlights that structured games in nature increase group cohesion, prosociality and emotional regulation- (Evans & Kim, 2013; Masten, 2014). Physical activity in a natural setting reduces stress and stimulates mutually supportive behaviour (White et al., 2019).
- Final metacognitive reflection: The guided verbalisation moment is based on Zimmerman's self-regulation model (2002) and the reflective education paradigm, which amplifies awareness of the learning process (Capra & Luisi, 2014; Sterling, 2001).

The synecological approach ensured constant attention to the dynamic interactions between the environment, the teacher, peers and the tasks proposed, enhancing the contextual and relational dimension of learning. Each session ended with moments of guided metacognitive reflection, during which participants were invited to verbalise their cognitive strategies, emotions experienced and learning acquired, thus consolidating their awareness of their own learning process.

4.1 Stages of the study

1. Preparatory phase (2 weeks):

-Teacher training: the teachers involved attended a specific training course on the synecological paradigm, covering both the theoretical foundations and the practical methods for conducting activities and managing group dynamics. In addition, the procedures for administering the assessment measures and collecting data were explained.

-Administration of the pre-test: before the start of the intervention, both cohorts (experimental group and control group) took a series of quantitative tests designed to measure the cognitive, social and environmental skills under study, in order to establish a baseline.

2. Intervention (12 weeks):

-The sessions took place twice a week, lasting 90 minutes each, always in natural urban environments, ensuring the continuity and frequency necessary for a lasting effect.

-Each meeting integrated different types of activities (science workshops, problem solving, artistic activities, cooperative games), structured according to a progressive path that stimulated active involvement and the practical application of skills.

-At the end of each session, there was a moment of metacognitive reflection, led by the teacher, during which the children discussed and compared their experiences, learning and difficulties, facilitating awareness and self-regulation of their learning.

3. Post-test:

-At the end of the 12 weeks, the quantitative measurements used in the pre-test were repeated to assess any improvements or changes in the skills investigated.

-At the same time, a wide range of qualitative data was collected through focus groups with participants and analysis of the logbooks completed during the activities, in order to gain a deeper understanding of the subjective experience and emerging dynamics.

4. Follow-up (3 months after the intervention):

-Three months after the end of the programme, further assessments were carried out to monitor the persistence of the effects achieved and verify the stability of the results over time.

-The assessments included repeated quantitative tests and qualitative interviews to explore the maintenance of skills and the transfer of skills to school and everyday contexts.

The Control Group, on the other hand, continued to carry out normal curricular activities in the classroom and school spaces, without additional exposure to nature-based education experiences or structured outdoor activities. In particular, the control group maintained its traditional teaching routine, including theoretical lessons and standard school activities, but without the integration of science laboratories, cooperative games in natural settings or moments of metacognitive reflection related to the environment.

Quantitative tools:

-Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997): a 25-item questionnaire, validated in school settings, for assessing social-emotional skills, prosocial behaviours and emotional-behavioural difficulties.

-Perceived Stress Scale – children's version (PSS-C; White, 2014): a 14-item self-assessment scale, adapted for school age, to assess the level of stress perceived in recent weeks.

-Continuous Performance Test (CPT): computerised test for assessing sustained attention and inhibitory control.

-Digit Span (Wechsler, 2003): WISC-IV subtest for measuring verbal working memory, including forward and backward tests.

-Ecological Awareness Questionnaire (Collado et al., 2013): a validated tool for measuring pro-environmental knowledge, attitudes and behaviours in children.

Qualitative tools:

-Structured observations: forms designed to record cooperative behaviour, interaction with the environment and active participation.

-Focus groups with students and teachers: guided discussions to explore perceptions, emotions and experiences related to the experience.

-Logbooks and narratives: written records and/or drawings made by students to document their weekly experience.

Quantitative analysis was conducted using mixed ANOVA (time $\times$ group) and Bonferroni correction.

Qualitative data were analysed using Braun and Clarke's inductive approach (2006) to identify emerging themes related to perceptions, emotions and behavioural changes.

5. Results

5.1 Quantitative results: pre- and post-intervention data (experimental group vs control group)

Variable	Test	Group	Pre-test (M $\pm$ SD)	Post-test (M $\pm$ SD)	Mean variation	p (ANOVA time $\times$ group)	Effect (partial η^2)
Self-esteem/self-efficacy	SDQ prosocial scale	Experiment	6.2	7.8 $\pm$ 1.0	+1.6	< 0.001	0.12
		Control	6.3 $\pm$ 1.2	6.4 $\pm$ 1.1	+0.1		
Perceived stress	PSS-C	Experimental	21.5 $\pm$ 4.3	15.2 $\pm$ 3.8	-6.	< 0.001	0.15
		Control	21.7 $\pm$ 4.2	20.8 $\pm$ 4.5	-0.9		
Sustained attention	CPT (attention score)	Experimental	72.4 $\pm$ 8.5	82.6 $\pm$ 7.9	+10.2	< 0.001	0.18
		Control	73.1 $\pm$ 9.0	74.0 $\pm$ 8.6	+0.9		

Variable	Test	Group	Pre-test (M ± SD)	Post-test (M ± SD)	Mean variation	p (ANOVA time × group)	Effect (partial η ²)
Working memory	Digit Span (total score)	Experimental	11.2 ± 2.3	13.6 ± 2.1	+2.4	< 0.001	0.10
		Control	11.1 ± 2.2	11.3 ± 2.1	+0.2		
Ecological awareness	Collado et al. questionnaire	Experimental	38.5	45.7 ± 5.0	+7.2	< 0.001	0.20
		Control	38.7 ± 5.6	39.3 ± 5.7	+0.6		

Follow-up results (3 months later)

Variable	Group	Follow-up (M ± SD)	Change from post-test	Significance compared to post-test
Self-efficacy	Experiment	7.4	-	Not significant
Perceived stress	Experimental	16.0 ± 3.9	+0.8	Not significant
Sustained attention	Experiment	81.0 ± 8.0	-1.6	Not significant
Working memory	Experiment	13.0 ± 2.2	-0.6	Not significant
Ecological awareness	Experim.	44.0 ± 5.2	-1.7	Not significant

Statistical analysis using mixed ANOVA showed significant effects of the intervention on socio-emotional well-being, cognitive skills and ecological

awareness, with clear differences between the experimental group and the control group.

- **Socio-emotional well-being:**

The experimental group showed a significant increase in self-efficacy and a reduction in perceived stress compared to the control group, as measured by the SDQ and PSS-C. This confirms the hypothesis that structured contact with nature, integrated into collaborative and reflective activities, supports emotional self-regulation and stress management. The decrease in perceived stress is particularly relevant in urban contexts, where environmental and social pressures can amplify emotional distress.

- **Cognitive skills:**

Data from CPT and Digit Span indicate significant improvements in sustained attention and working memory in the experimental group. These results are in line with the findings of Berman et al. (2008) and Bratman et al. (2019), which highlight the restorative effects of natural environments on executive functions. The synecological approach, by promoting dynamic interactions between environment and learning, seems to enhance not only cognitive performance but also motivation and engagement during activities.

- **Ecological awareness and pro-environmental behaviour:**

The questionnaire by Collado et al. (2013) found a significant increase in environmental knowledge and the adoption of sustainable behaviours in the experimental group, confirming that direct and contextualised experience in urban green spaces promotes the development of an emotional and responsible relationship with nature.

- **Persistence of effects:**

The 3-month follow-up results show that the benefits in terms of well-being and cognitive skills are maintained, highlighting the potential for a lasting effect, albeit with a slight attenuation. This finding underscores the importance of ongoing and integrated projects to consolidate progress.

5.2 Qualitative results

Qualitative analysis, conducted through focus groups, structured observations and logbooks, provided a rich and multifaceted picture of the experience of students and teachers during the nature-based education programme. The emerging data

were organised into three main macro-themes: socio-emotional well-being, cognitive processes and active learning, and ecological awareness and environmental responsibility.

- Emotional engagement and sense of belonging: Through narratives and focus groups, students expressed increased motivation and enjoyment in learning, associating contact with nature with feelings of calm and fun. Cooperative dynamics and group games strengthened the sense of mutual trust and belonging to the school community.
- Emerging environmental awareness: Many children reported developing greater awareness of urban ecosystems, showing curiosity and responsibility in caring for green spaces, as evidenced by their behaviour during data collection and ecological problem-solving activities.
- Perceived synecological approach: Teachers recognised the value of the systemic approach that integrates environment, peers and content, appreciating the consistency between activities and educational objectives. The final metacognitive reflection was seen as an effective tool for consolidating learning and promoting student autonomy.
- Perceived challenges and limitations: Some participants reported organisational difficulties and the need for more training for teachers with less experience in outdoor teaching. In addition, the duration of the project was considered insufficient to further extend the benefits and involve families and communities.

Students often described an improvement in their emotional state and relationships with their peers. One child shared: 'When we're outdoors, I feel calmer and happier, like if I could really breathe.' (Boy, 9 years old). Many reported a greater sense of confidence in their abilities: 'Solving problems together made us feel like a team, and that helped me at school too' (girl, 10 years old). Teachers confirmed the reduction in tension and conflict observed in the classes involved: 'I noticed that after the nature activities, the children are calmer, more attentive and less agitated' (Primary school teacher). The reflections written in the diaries also highlighted greater emotional awareness and self-regulation skills: "Today I learned to breathe slowly when I feel angry and to walk calmly in the meadow." (Diary of a student).

The qualitative analysis was conducted following Braun and Clarke's (2006) inductive thematic approach in six stages:

1. Familiarisation with the data – repeated reading of focus group transcripts, observations and logbooks to capture initial meanings.
2. Generation of initial codes – open coding of relevant text segments, without predefining categories, using qualitative analysis software (e.g. NVivo).
3. Theme search – aggregation of codes into potential emerging themes related to well-being, cognitive processes and ecological awareness.
4. Review of themes – verification of the internal consistency of the data for each theme and the distinction between different themes.
5. Definition and naming – assigning descriptive and interpretative labels to themes, linking them to research objectives.
6. Report writing – integration of themes with direct quotations and comparison with the literature to discuss convergences or divergences with previous studies.

To ensure reliability, two researchers independently coded 20% of the material, comparing results and resolving discrepancies through discussion (inter-coder reliability). An audit trail was also maintained with analytical memos and interpretative decisions to ensure methodological transparency.

In summary, the qualitative data confirm and enrich the quantitative results, showing how the synecological approach and direct experience in nature not only improve measurable parameters but also generate significant changes in children's emotional, cognitive and relational experiences. The direct voices of students and teachers testify to an integrated growth path, in which nature, learning and community intertwine in a functional and transformative way.

6. Discussion

The results of this study confirm and expand the body of knowledge regarding the positive effects of nature-based education on primary school children, especially in urban settings with limited daily access to green spaces. The structured intervention, integrated into the school curriculum, showed significant and sustained improvements in students' socio-emotional well-being, cognitive skills and ecological awareness, with lasting effects over time. This confirms the validity of the synecological approach as an innovative pedagogical model capable of

responding to the multidimensional needs of contemporary learners. The increase in self-efficacy and the significant reduction in perceived stress in the experimental group confirm the importance of regular contact with nature as a protective factor for children's mental health. These results are in line with previous studies highlighting how exposure to green spaces promotes better emotional balance and a greater capacity to manage negative emotions (Berto, 2005; Bratman et al., 2019). The reduction of perceived stress, in particular, is crucial in dense and complex urban contexts, where social pressure, noise and crowding contribute to high levels of anxiety and distress in children (Evans & Kim, 2013). The synecological approach, which considers the interconnection between the environment, individuals and communities, is particularly effective in promoting emotional self-regulation. The collaborative and reflective activities proposed have probably facilitated the establishment of a sense of emotional security and belonging, which are fundamental elements for the development of resilience (Masten, 2014). In this sense, the role of teachers as facilitators of an inclusive and supportive environment is crucial: specific training on synecological principles has enabled them to competently guide experiences that enhance the relational and environmental dimensions of learning. The significant increase in sustained attention and working memory performance highlights how interaction with the natural environment can have a direct impact on executive functions, which are the basis of many school learning processes (Diamond, 2013). This finding reinforces the hypotheses of Berman et al. (2008) about the restorative effect of natural environments on cognitive load, reducing mental fatigue and improving the ability to focus and maintain attention on complex tasks. Furthermore, the enhancement of working memory suggests that natural experiences stimulate not only simple attention, but also higher-level cognitive abilities such as information manipulation and organisation. It can be hypothesised that collaborative problem-solving activities and metacognitive reflections contributed to consolidating these skills by activating more effective learning strategies and promoting greater motivational involvement (Zimmerman, 2002). By focusing on the relationship between environment and learning, the synecological approach overcomes the traditional dichotomy between subject content and context, offering an integrated experience that involves cognitive, emotional and social aspects. This model could be a useful reference point for rethinking teaching in urban schools, encouraging more active, contextualised and meaningful learning. The significant increase in ecological awareness and pro-environmental behaviour is one of the most relevant and promising outcomes of the programme, highlighting the educational potential of direct and contextualised experiences in urban green

spaces. Active involvement in scientific observation, data collection and ecological problem solving has fostered not only the acquisition of knowledge, but also the formation of an emotional bond with the surrounding environment, a key factor in the development of ecological empathy and civic responsibility (Chawla, 2015). These results confirm the validity of the theory of direct experience (Sobel, 2004) and are in line with studies that have highlighted how learning based on contact with nature can act as a lever for the construction of long-term sustainable behaviours (Collado et al., 2013). In particular, urban nature, often perceived as marginal or degraded, has been transformed into an educational context rich in stimuli and meaning, helping to overcome the dichotomy between the natural and built environments.

The synecological approach, integrating environment, peers, teachers and content, has created an ecological learning system that is not limited to the transmission of knowledge, but encourages the activation of responsible practices, a sense of belonging and civic engagement. This represents an original contribution to traditional approaches to environmental education, which are often limited to sporadic or theoretical interventions. Data collected at the three-month follow-up indicate that the positive effects of the programme are maintained over time, albeit with a slight attenuation, suggesting the importance of ongoing interventions to ensure the stability of results. This evidence is particularly relevant, as many educational programmes show short-term effects without consolidation (Rickinson et al., 2004). Continuity and integration into the school curriculum are therefore key elements in transforming the nature education experience into a lasting and meaningful learning process. Metacognitive reflection and moments of collective sharing can serve as anchors to consolidate the skills acquired, promoting greater self-awareness and awareness of one's role in the social and natural ecosystem. The results of this study offer an important contribution to the definition and validation of the synecological approach as an innovative educational paradigm. This model goes beyond the reductionist view of learning as an individual and cognitive process, proposing instead a systemic view that considers the dynamic interaction between the environment, people, social contexts and educational content. This integrated perspective is based on the principles of complexity and systemicity (Capra & Luisi, 2014), proposing a teaching approach that recognises the centrality of relationships and the educational ecosystem. In the urban context, where opportunities for contact with nature are limited, the synecological approach represents a strategy for enhancing every green space as an educational, social and emotional resource. The synecological paradigm also allows us to overcome the separation between formal and informal learning, integrating

experiential moments with meta-cognitive reflections and collaborative activities. This promotes greater motivation, autonomy and responsibility in students, which are essential elements for the formation of aware and active citizens. The effectiveness of the experimental programme suggests that nature-based education integrated into the school curriculum can be a real opportunity to improve the quality of the school experience in urban contexts. Schools could adopt similar models, tailoring them to local characteristics and available resources. In particular, teacher training emerges as a critical factor for the success of such interventions: only through a deep understanding of the synecological paradigm and related teaching techniques is it possible to design and implement meaningful and coherent activities. Educational policies should promote the systematic inclusion of nature education programmes, recognising their cross-cutting value that goes beyond individual disciplines and contributes to the integral development of the person. Investments in green school infrastructure and collaboration with local authorities and environmental institutions can amplify the impact of such interventions, making nature a real laboratory for learning and well-being. Despite the positive results, the study has some limitations that should be considered for the generalisation and refinement of the interventions. The 12-week duration, although significant, may not be sufficient to fully investigate the long-term stability of the effects, suggesting

Conclusions

The results of this study confirm that integrating nature-based educational experiences into the urban school curriculum, designed according to the principles of the synecological approach, has positive and multidimensional effects on the well-being, cognitive skills and pro-environmental behaviour of primary school children. This innovative pedagogical model not only significantly improves self-efficacy and reduces perceived stress, but also promotes the development of fundamental executive functions such as sustained attention and working memory, which are key elements for academic success and coping with daily challenges. The synecological approach, which values the interrelationship between the natural environment, people and communities, has proven effective in promoting emotional self-regulation and resilience, thanks to its emphasis on collaborative, reflective activities and the construction of a sense of security and belonging. The active role of teachers, who are appropriately trained in these principles, is crucial in creating an inclusive and supportive environment in which learning becomes an integrated and meaningful experience. The enhancement of ecological awareness

and pro-environmental behaviour is one of the most promising outcomes of the programme, highlighting the importance of direct, contextualised and repeated experiences over time in building an emotional connection with the environment and promoting long-term civic responsibility. The transformation of often marginalised urban green spaces into stimulating educational laboratories shows how it is possible to overcome the traditional separation between the natural and built environments, offering children a concrete opportunity for experiential and conscious learning. The data collected at the three-month follow-up confirm the persistence of the positive effects, albeit with a slight attenuation, highlighting the importance of continuous and integrated interventions in the school curriculum to ensure the stability and consolidation of the skills acquired. Metacognitive reflection and moments of collective sharing are fundamental tools for anchoring such learning and promoting greater awareness of one's role within social and natural ecosystems. This study contributes significantly to the definition and validation of the synecological approach as an innovative educational paradigm, which goes beyond the reductionist view of learning as an individual and cognitive process, proposing instead a systemic, complex and integrated perspective. This model is particularly relevant in urban contexts, where limited access to nature can be compensated for by teaching methods that enhance the value of every green space as an educational, social and emotional resource. Finally, the practical implications of this study suggest the need for educational policies that promote the systematic and structured inclusion of nature-based education programmes, with investment in green school infrastructure and collaboration between schools, local authorities and environmental institutions. Specific and in-depth teacher training emerges as a key factor in the success of such initiatives, enabling the design and implementation of activities that are consistent with synecological principles and capable of responding to the multidimensional needs of contemporary learners. Despite the encouraging results, the study acknowledges some limitations, such as the 12-week duration, which may not allow for a full assessment of the long-term stability of the observed effects, highlighting the importance of further longitudinal research and insights into the role of contextual and individual variables in mediating the results. In summary, nature-based education integrated into the urban school curriculum, based on the synecological approach, is an effective and promising educational strategy for promoting the holistic development of children, improving their well-being, cognitive skills and environmental responsibility, and contributing to the formation of resilient, aware and active citizens.

References

- Beery, T., Jönsson, K. I., & Elmberg, J. (2022). Outdoor learning in primary school: A case study in Swedish teacher education. *Journal of Adventure Education and Outdoor Learning*, 22(4), 337–351. <https://doi.org/10.1080/14729679.2021.1874355>
- Beery, T., Raymond, C. M., & Kyttä, M. (2022). Nature-based learning and wellbeing: A systematic review. *Journal of Outdoor and Environmental Education*, 25(2), 115–132. <https://doi.org/10.1007/s42322-021-00091-4>
- Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science*, 19(12), 1207–1212. <https://doi.org/10.1111/j.1467-9280.2008.02225.x>
- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology*, 25(3), 249–259. <https://doi.org/10.1016/j.jenvp.2005.07.001>
- Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., ... & Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, 5(7), eaax0903. <https://doi.org/10.1126/sciadv.aax0903>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Capra, F., & Luisi, P. L. (2014). *The systems view of life: A unifying vision*. Cambridge University Press.
- Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, 30(4), 433–452. <https://doi.org/10.1177/0885412215595441>
- Collado, S., Staats, H., & Corraliza, J. A. (2013). Experiencing nature in children's summer camps: Affective, cognitive and behavioural consequences. *Journal of Environmental Psychology*, 33, 37–44. <https://doi.org/10.1016/j.jenvp.2012.08.002>
- Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. (2012). Researching health inequalities in adolescents: The development of the Health Behaviour in School-aged Children (HBSC) Family Affluence Scale. *Social Science & Medicine*, 66(6), 1429–1436. <https://doi.org/10.1016/j.socscimed.2007.11.024>

de Vries, S., Verheij, R. A., & Groenewegen, P. P. (2013). Natural environments — and self-regulation. *Journal of Environmental Psychology*, 73, 44–52. <https://doi.org/10.1016/j.jenvp.2013.08.002>

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, 64, 135–168. <https://doi.org/10.1146/annurev-psych-113011-143750>

Dyment, J. E., & Bell, A. C. (2008). Grounds for movement: Green school grounds as sites for promoting physical activity. *Health Education Research*, 23(6), 952–962. <https://doi.org/10.1093/her/cym064>

Ernst, J. (2014). Early childhood educators' use of nature-based learning for children's healthy development. *International Journal of Early Childhood Environmental Education*, 2(1), 4–23.

Evans, G. W., & Kim, P. (2013). Childhood poverty, chronic stress, self-regulation, and coping. *Child Development Perspectives*, 7(1), 43–48. <https://doi.org/10.1111/cdep.12013>

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, 38(5), 581–586. <https://doi.org/10.1111/j.1469-7610.1997.tb01545.x>

Hartmut Rosa. (2015). *Social acceleration: A new theory of modernity*. Columbia University Press.

Hughes, J., Richardson, M., & Lumber, R. (2021). Evaluating connection to nature and the relationship with well-being. *Ecopsychology*, 13(1), 24–36. <https://doi.org/10.1089/eco.2020.0020>

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Louv, R. (2016). *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin Books.

Masten, A. S. (2014). Global perspectives on resilience in children and youth. *Child Development*, 85(1), 6–20. <https://doi.org/10.1111/cdev.12205>

Masten, A. S. (2014). *Ordinary magic: Resilience in development*. Guilford Press.

Morsanuto, S., Peluso Cassese, F., Tafuri, F., & Tafuri, D. (2023). Outdoor education, integrated soccer activities, and learning in children with autism spectrum disorder: a project aimed at achieving the sustainable development goals of the 2030 agenda. *Sustainability*, 15(18), 13456.

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2004). *A review of research on outdoor learning*. National Foundation for Educational Research and King's College London.

Sobel, D. (2004). *Children's special places: Exploring the role of forts, dens, and bush houses in middle childhood*. Wayne State University Press.

Sobel, D. (2004). *Place-based education: Connecting classrooms & communities*. Orion Society.

Sterling, S. (2001). *Sustainable education: Re-visioning learning and change*. Green Books.

Stilwell, C., Martuzzi, M., & Neuman, M. (2017). Nature and mental health: An ecosystem approach to supporting well-being. WHO Regional Office for Europe. <https://www.euro.who.int>

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV)*. The Psychological Corporation.

Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments*, 16(1), 1–24.

White, B. A. (2014). Measuring perceived stress in children: Development of a child version of the Perceived Stress Scale. *Journal of Child Health Care*, 18(4), 457–465. <https://doi.org/10.1177/1367493513496938>

White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., ... Fleming, L. E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports*, 9, 7730. <https://doi.org/10.1038/s41598-019-44097-3>

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2