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STUDY ON CURRICULUM MECHANISMS AND PATHS OF ATTENTION TRAINING FOR ALL, IN CHINA

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ABSTRACT
Through a comparative analysis of 50 global nature-education programmes, this study concludes that nature-based activities are uniquely suited for cultivating perceptual and attentional skills in young children, and can support children with ADHD:a Design for All approach. Building on this foundation, we propose an empirical study on the Relax–Train Swap Model (RTSM), a novel training framework for children aged 2–7. The RTSM integrates 5-minute low-stimulation nature exposure (informed by Attention Restoration Theory) with 5- to 10-minute blocks of the "Find–Observe–Draw" (FOD) task.This FOD sequence is designed to engage core attentional processes: finding targets inhibitory control, observing sustains attention, and drawing triggers cognitive flexibility through perspective shifts. Embedded in a Relax–Train–Relax loop, the model posits that nature education can be transformed from cognitive restoration into a measurable pathway for ecological literacy and holistic development. This study proposes a model's curriculum integration with real-time observational quantification, turning "nature exposure" into "visible attention training." A challenge is posed by overgeneralization, since outcomes are moderated by contextual factors like teacher expectancy. Future work will focus on empirical validation of the proposed mechanisms and enhancing the model's local adaptability for scalable application.

Keywords: Nature Education, Attention Restoration, Attention Mechanism, Children's Cognitive Growth, Education For ALL

1 INTRODUCTION

1.1 Research background

Contemporary urban childhood has become globally characterized by a profound disconnection from nature. Research shows that traditional kindergartens in China over-emphasize academic instruction, requiring 12–40 hours per week of in-class time [1] and often assigning primary-level tasks such as arithmetic drills and poetry recitation following the popular concept "Win at the starting line".which pushes children master primary-level content during the preschool years in order to outperform peers and thereby secure future academic success.Such passive learning crowds out autonomous exploration, heightens frustration, and reduces sustained attention to below 10 minutes on average [2], laying hidden risks for later development. Kaplan's Attention Restoration Theory (ART) [3] likens directed attention to a muscle: it must relax in a low-stimulus, high-fascination natural setting before it can tense again. Empirical studies confirm that 20 minutes of nature activity significantly improves attention performance in children with ADHD (Digit Span scores post-park walk > urban setting, $p < 0.05$) [4]Methods beyond drug interference contribute to the Design-for-All approach of this research.[5].Yet ART faces two contradictions in early-childhood education.First, a logical conflict: ART stresses cognitive unloading, but education demands moderate challenge to foster development; mere restoration cannot satisfy attention-training needs.Second, a lack of theoretical guidance: nature education often falls into an "activity-based, superficial" trap, lacking a systematic curriculum that turns natural settings into structured attention-training fields [6].

This study therefore seeks to explore possibilities of a systematic attention-training mechanism within nature education—one that accounts for the depletion of directed attention by intensive training while avoiding the ineffectiveness of a "free-play-only" outdoor model.

1.2 Research questions

·Can structured nature-education curricula—based on a relaxation-training alternation model—effectively train young children's attention?
·How can the restorative effects of natural environments on executive attention be harnessed and coupled with dynamic target-tracking tasks to systematically enhance attentional control (focusing on inhibitory control, cognitive flexibility, and sustained attention) in 3- to 6-year-olds?

2 REVIEW OF RESEARCH ON NATURE EDUCATION

Nature-based education is an educational paradigm that uses the natural environment as its primary setting. Through interaction, experience, and practice with nature, it seeks to foster holistic development of the individual, in the cognitive, emotional, physical, and spiritual aspects. Its core tenets are respect for nature, harmony with natural rhythms, and return to the natural world; it emphasises sensory stimulation, hands-on exploration, and emotional engagement with nature to promote all-round growth [7]. Theoretical foundations include naturalistic educational philosophy (e.g., Rousseau's ideas on education), experiential learning theory, and ecological education concepts [8]. Typical practices comprise outdoor activities, nature observation, and natural-history inquiry.

2.1 International development status

Internationally, nature-based education research is advancing in a coordinated manner toward empirical theorization, systematic curriculum design, and technological integration. At the level of attention mechanisms, the empirical foundation of Attention Restoration Theory (ART) continues to be deepened: Johnson et al. (2019) [9] used pupillary-response indices to demonstrate that natural environments significantly enhance children's endogenous attention (+18 %), while the classic study by Taylor & Kuo (2009) [4] further verified the intervention effect of natural exposure on attention in children with ADHD (Cohen's $d = 0.77$,with $d \geqslant 0.5$ generally regarded as practically meaningful).
In curriculum design, the Nordic "Forest School" model innovatively integrates dynamic tasks (e.g., insect-trajectory tracking, terrain mapping) and uses goal-directed games to improve executive functions [10]. On the technology-fusion side, head-mounted eye trackers and other biosensors enable real-time quantification of visual-exploration behaviour, pushing training parameters toward precision. However, it seems that the design of standardised dynamic task chains could benefit from further, structured studies.

2.2 Domestic development status

At present, nature-based education in China is characterized by parallel advances in technological application and contextualized adaptation, yet it still faces the challenge of insufficient systematic curriculum construction.[11] Measures of cognitive benefits are becoming increasingly refined: for example, Luo et al. (2024) used VR eye-tracking to show that dynamic waterfront scenery increased children's gaze duration by 37 % [12].The study found that children in public preschool programs who received nature-based pedagogy scored significantly higher on post-test measures of attention/impulse control than those exposed to blended or less nature-intensive practices.[13]
Nevertheless, curriculum design still faces two challenges: first, attention training remains fragmented—current programmes mostly emphasise nature experiences (e.g., plant literacy) but lack structured task chains (Peng et al., 2024) [14]; second, interventions for special populations lag behind—nature courses for children with ADHD still focus on emotional support rather than attention-targeted RCT evidence [15].

2.3 Innovation point

The authors have yet to find in literature the following direction, which could hold an interest within a future design framework of testing activities and further evaluation.
1. a task-rhythm optimisation: a timed sequence of "relax-train" alternating tasks forms a replicable curriculum chain.
2. a cognitive-mechanism integration: dynamic coupling of environmental restoration effects with

executive-function training.

A potential theoretical innovation proposed by this study lays in combining Kaplan's ART "soft-fascination → attention restoration" mechanism with dynamic target-tracking tasks; we propose exploring the possibilities of "environment-empowerment & task-activation" dual-pathway framework.

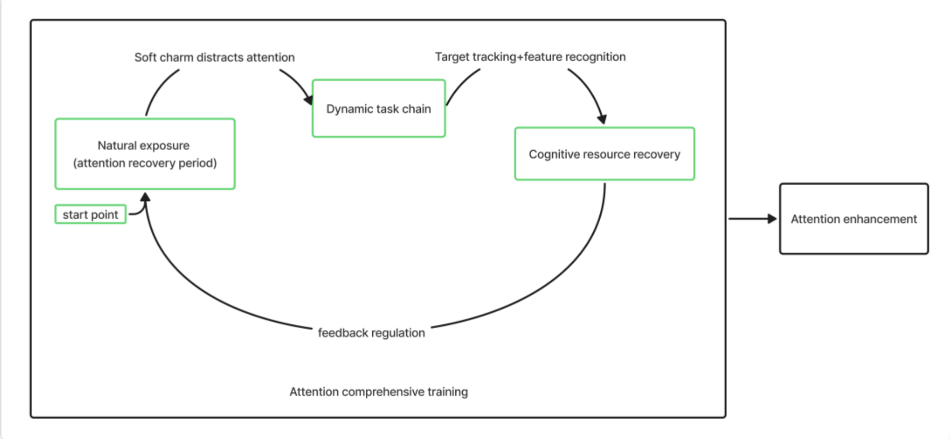

Figure 1. Attention synthesis training path diagram, drawn by the authors

3. RESEARCH SIGNIFICANCE

Theoretical significance

This study integrates attention-development mechanisms, attention-restoration theory and cognitive theory into a complete "restore→train" logic, offering a potential design direction for nature-education curricula. It structurally links an ART-based relaxation cycle with dynamic visual tasks; whereas previous work typically validated nature exposure or cognitive training separately, this study propose to close the "restore-activate" loop. Ecologically valid tasks replace laboratory ANT tests with "F-O-D", boosting child engagement [16].

Policy significance

The study responds to China's National Development and Reform Commission Guidelines for Child-Friendly Cities [17], which call for "more out-of-school activity space and facilities for labour education, practical training, science experience and quality-expansion programmes". Leveraging the "double reduction" policy, it provides evidence for building nature-education sites and supports holistic cognitive, social and emotional development [18].

Practical significance

The findings of this study could guide methodological innovation in nature education by blending design thinking, cognitive-growth frameworks, ART and attention-training theory. The resulting curriculum could enrich preschool programmes, enhancing attention, creativity, executive function and social skills. Teachers would gain a scientific basis for developing nature-based activities.Once attention training becomes a framework that parents can freely adapt and implement—while watching their children's progress visualized in real time—those who want to cultivate better focus will find themselves continually motivated.

Social significance

Improved attention control through nature education can boost learning focus and lay foundations for lifelong learning. Returning children to nature provides rich natural stimuli, promotes educational equality and narrows developmental gaps [19]. At societal level, it cultivates sustainable-development awareness from early stages, strengthening overall environmental consciousness.

4. THEORETICAL BASIS

4.1 Attention development mechanisms

Attention is the brain's mechanism for the selective allocation of limited processing resources and for inhibitory control. It involves amplifying target information (signal enhancement) while suppressing interfering information (noise inhibition), thereby supporting sustained focus, task switching, and executive control. This process is implemented primarily through the frontoparietal network and the anterior-cingulate/dorsolateral-prefrontal circuit, which jointly realize three functional components of attention—orienting, sustaining, and executing [20]. When these neural inhibitory loops are depleted by prolonged use, "directed-attention fatigue" occurs, manifesting as increased distractibility, reduced impulse control, and a decline in cognitive performance [21].

Attention mechanism	Definition	Example
Directed attention	Quickly direct limited resources towards target stimuli while actively suppressing interference.	Students quickly identify the vocalizations of specific birds in the forest (target stimuli) while ignoring wind sounds and other animal calls (interference suppression)
Sustained attention	Maintain vigilance and processing towards the same target for a long time to prevent missing information.	Continuously observe the flight trajectory and status of birds to avoid missing subtle changes due to distraction
Executive attention	Monitor and adjust attention strategies, resolve conflicts, correct errors, and switch tasks.	Switching observation targets during field investigations (such as shifting from birds to plants) and adjusting recording strategies to cope with changing targets

Figure 2. Structure of attention mechanism, reproduced from [22] the examples are from authors

4.2 Attention Restoration Theory (ART)

Restorative experience and stress reduction: Natural environments indirectly enhance children's attention and emotional stability by lowering stress and physiological arousal (e.g., heart rate, blood pressure) and promoting self-regulation [23]. Temporarily leaving stressful sources and entering a calm, serene setting allows gradual stress release through contact with nature.

ART: The "soft fascination" of natural settings can restore depleted directed attention by engaging involuntary attention and promoting restored attention, thereby reducing cognitive fatigue [3]. Involuntary attention refers to low-intensity, non-threatening stimuli constantly present in nature—rustling leaves, bird calls, gentle breezes—which gently draw one's focus to every passing breeze or insect chirp, shifting attention from internal stressors to soft external observation and allowing tense nerves to relax. Empirical studies show that walking in natural environments or viewing nature images improves directed-attention performance, as verified through reverse-digit-span and attention-network tasks [24].

4.3 Cognitive theory

Cognitive theory encompasses perception and attention; memory systems (including working memory and long-term memory, with the latter developing markedly after age four) [25]; language acquisition and development; concept formation and thinking; executive functions; metacognition—the monitoring and regulation of one's own cognitive processes; and social cognition, which involves understanding others' intentions, emotions, and beliefs during social interaction [26].

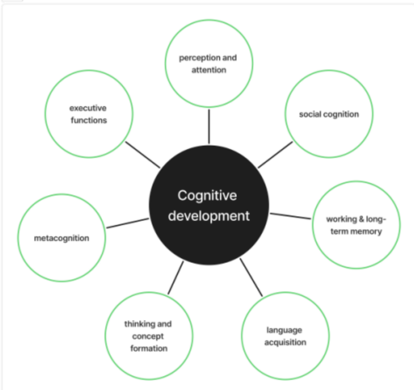

Figure 3. 7 dimensions of cognitive growth, reference to [27] drawn by the authors

4.4 Cognitive Development Theoretical Framework

Rousseau's "Return to nature" seeks to preserve children's innate dispositions and opposes premature knowledge transmission.[28]

Piaget posits cognitive development as a constructive process in which children actively build knowledge through interaction with their environment; each developmental period exhibits distinct cognitive characteristics, providing a stage-based theoretical framework for research.
Children's cognitive development is divided into four stages—sensorimotor, pre-operational, concrete operational, and formal operational—each with specific cognitive features and abilities [29].

Piaget's theory of cognitive development in children	
Perceived motor stage (0-2 years old)	Pre computational stage (2-7 years old)
①Reflexive actions, beginning of symbolic thought. ②Functioning of object permanence and beginning rudiments of language ③Gains control of reaching, grasping, bolding behavior. ④Behavior Develops an understanding of gravity ⑤Reads adults" faees for emotion	①Intelligence becoming symbolic ②Beginning to master native language ③Symbolie imagery, mentally compares and represents objects ④Thinks perceptually ⑤Egocentrism of thought, considering and solving problems internally
Specific calculation stage (7-11 years old)	Formal operation stage (11-16 years old)
①Intellect may be symbolic and logical ②Beginning rational thought, beginning to understand transitivity ③Beginning to understand conservation a) Understands reversibility of thought b)Thinking may still be limited to concrete phenomena over past and present experience ④Piaget noted the ages of each subject interviewed as a representation of thinking at each stage of development ⑤Thinking not totally abstract	①Abstract thinking develops ②Can introspeet and reflect about own thinking ③Have their own thought processes ④Meta cognition, can think about hypotheses and propositions withoutconcrete objects ⑤Can master more complex seientifie and mathematical operations ⑥Can use reversibility and reciprocity ⑦Can use laneuage in problem solving, discussion, and decision making

Figure 4. Piaget's stage theory [29] redrawn by the authors

According to Piaget's theory, children in the concrete operational stage (7–11 years) are suited to attention training; therefore, the present study targets children aged 2–7 years, whose cognitive abilities are developing progressively and who can understand complex tasks and instructions. Considering that the setting of this study requires young children to have a certain level of cognitive ability and be able to understand teachers' instructions, the age range is set at 4-7 years old [30].
The authors explore through a case studies analysis, the potentialities of combining learning by doing [31] and sensory-first exploration [32] —ideas that constitute an early source of exploratory, experiential learning for pre-schoolers [33]. When children learn actively, interest is engaged quickly; sustained interest lengthens focus, strengthens self-regulation, and naturally enhances attentional capacity.[32]
Lev Vygotsky's Zone of Proximal Development (ZPD) theory asserts that young children's development is achieved through interaction with more experienced others—adults or more capable peers—in the social environment.[34][35] The theory distinguishes two developmental levels: the "actual developmental level" shown when a child solves problems independently, and the "potential developmental level" attainable with guidance or collaboration; the distance between them constitutes the ZPD. Educators must provide scaffolding—temporary, incremental support tailored to the learner's current ability—to help children bridge this cognitive gap, gradually internalize knowledge and skills, and ultimately achieve autonomous development. [36]This perspective foregrounds the central role of sociocultural contexts and cooperative learning in cognitive development, offering a key theoretical foundation for the present educational-practice study.
In summary, a theoretical support framework for this study can thus be established, as shown in Figure 5.

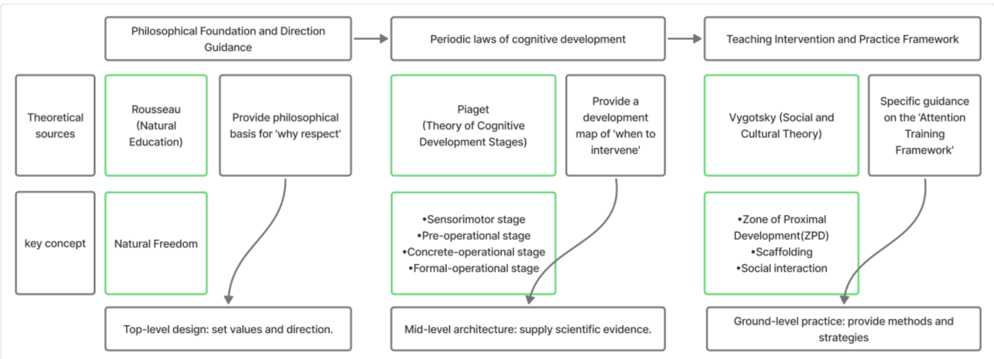

Figure 5. Theoretical support framework,drawn by the authors

5. CASE STUDY AND ANALYSIS

5.1 Case analysis

To systematically map the practical forms and intervention features of nature-based education, this study employed a multi-source case-analysis approach.[37] We conducted wide-scale retrieval and screening of academic literature, professional-organisation websites, online long-form articles and short-video platforms. A total of 50 valid cases were collected and collated, covering programmes from Europe, the United States, East Asia and China. After source verification, content coding and feature extraction, a case bank spanning seven dimensions of cognitive growth was established. Using the analytic logic shown in Figure 6, we derived pathways and curricular-design directions for cultivating children's attention through nature education.

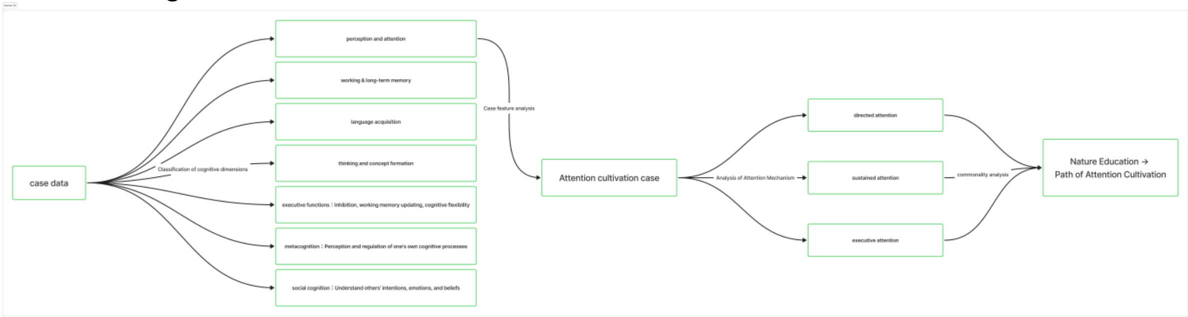

Figure 6. Case analysis logic diagram, drawn by the authors

The 50-case review showed how nature lessons empower at first the dimension of "perception and attention". Therefore, this study focuses first on this dimension, deepening the understanding of the processes involved in sharpening children's attention. In a second stage, the study will address the other two dimensions of cognitive growth (as shown in Figure 7): "concept forming" and "executive function," which also benefit from nature, as the case study review shows, but need more word checks and hands-on tasks to help kids curb impulses and stay focused.[38]

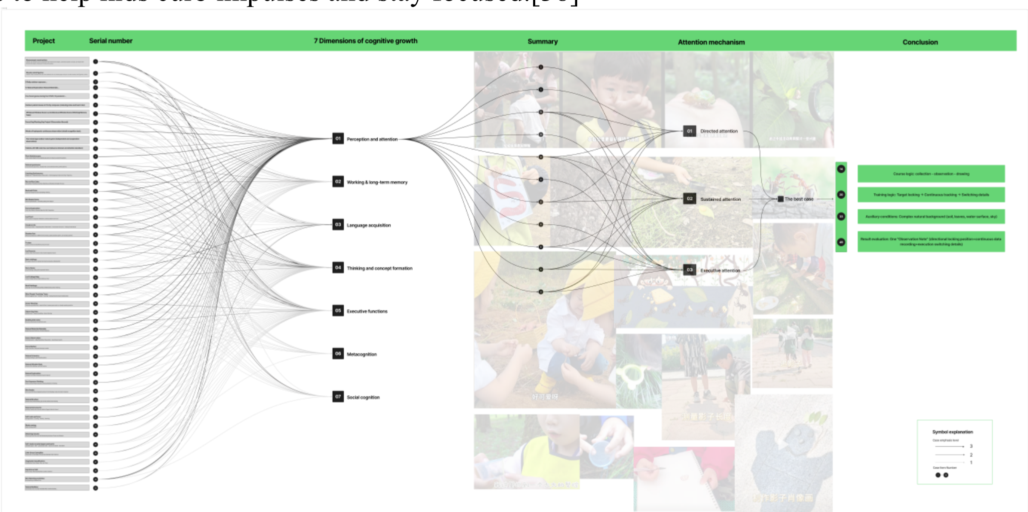

Figure 7. Case analysis, drawn by the authors

5.2 Analysis Conclusions

The above analysis yields design guidelines for attention cultivation through nature education across four dimensions: (i) curriculum-design, (ii) attention-training, (iii) auxiliary instructional conditions, and (iv) outcome assessment. These patterns can be first generalised and then localised—substituting contextual carriers to suit regional natural environments—thereby greatly enriching perception- and attention-oriented nature-education curricula. By concretising and standardising the dual outcomes of nature education and attention training, the guidelines accelerate sectoral maturation. Once generalised, they allow parents and children to design their own courses, further extending the approach's applicability.

6. RESEARCH PLAN

6.1 Experimental Plan

In planning a pilot test of the research findings, the next step is to design materials for relevant course tasks and conduct deployment experiments in pilot schools. The specific plan is detailed in Table 1.

Table 1. Teacher Observation Record Form

Item	Details
Possible Partner School	Baoshan Nanda Experimental School, Shanghai
Planned Dates	December 2025
Flow	Pre-test attention → 5 min nature relax → 20-min RTSM training (during weekly craft class) → post-test attention → 4-week follow-up
Groups	36 kids in RTSM nature-attention group, 36 in regular outdoor free-play group
Tools	Child ANT test + teacher rating scale
Staff	1 research assistant, 1 classroom teacher, 1 safety officer

Considering that real classrooms are often messy and teachers are busy, the authors condensed and clarified the training into a simplified set, making it easy to implement for the actors involved: Figure 8 illustrates the 15-minute F-O-D loop. Teachers can select one Find card, one Observe card, and one Draw card that match their current activity context, hand out the record sheet, and the activity can begin without further investment of time or preparatory actions. Such a process is illustrated in Figure 8.

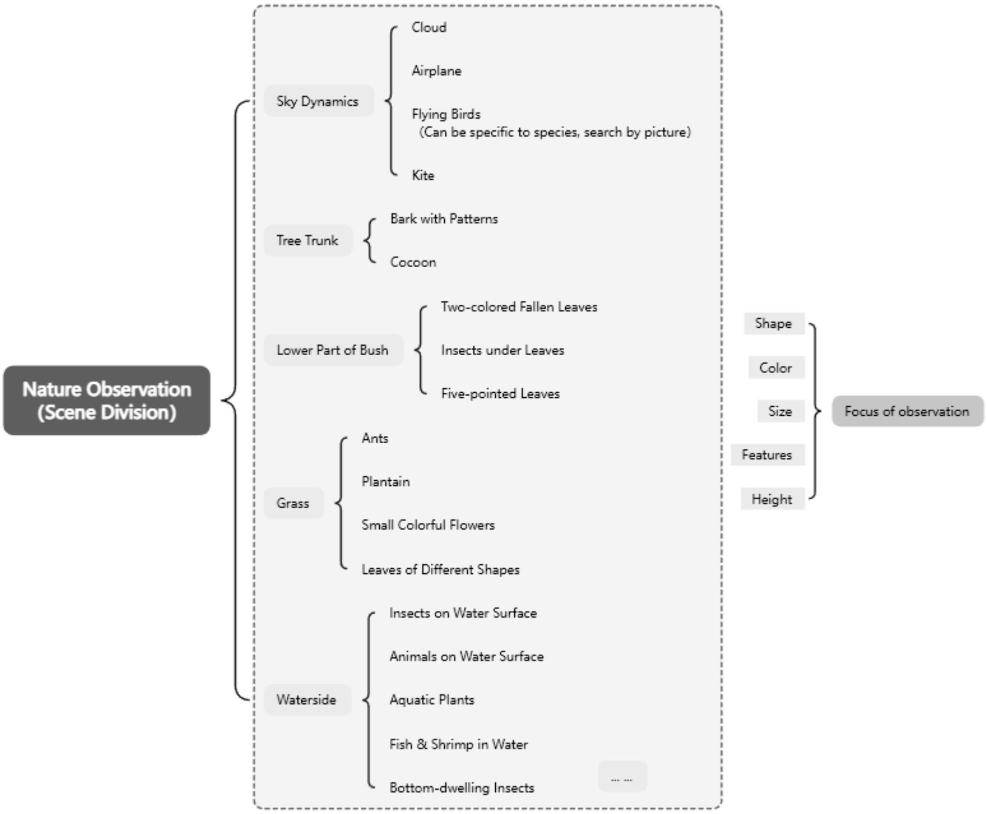

Figure 8. Analysis of experimental cards, drawn by the authors

Figure 9. Teachers' operation process, drawn by the authors

7. EXPERIMENTAL LOGIC

7.1 Course logic

Curriculum-design logic emerged from the cross-case analysis of high-scoring programmes, revealing a common three-step chain: Collect → Observe → Draw. Research [4] indicates that 20 min of nature exposure improves attention in children with ADHD; training and session durations were therefore benchmarked against this value. The detail of the three steps follows.

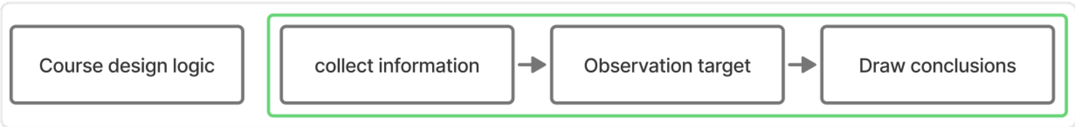

Figure 10. Course logic, drawn by the authors

Collect information: Children are given a specific collection task and time limit before gathering, exercising inhibitory control and rapid filtering of distractors. For example, the UK Field Studies Council (FSC) asks learners to close their eyes, feel a tree trunk and describe its features, activating sensory acuity [39].
Observe details: The instructor rhythmically changes the observation target, guiding attention to key attributes (insect trajectory, leaf venation) and prolonging concentration. Comparative analysis (e.g., differences between similar species) deepens cognition and fosters perceptual summarisation.
Draw results: Observations are converted into sketches or symbolic records, forcing transfer from working memory to long-term memory. Sketch/symbol formats are broadly applicable and allow quick, intuitive representation of what the learner saw.

7.2 Training logic

Attention-training logic integrates natural-education activities with attention mechanisms to form a lock-on → sustain → switch paradigm.

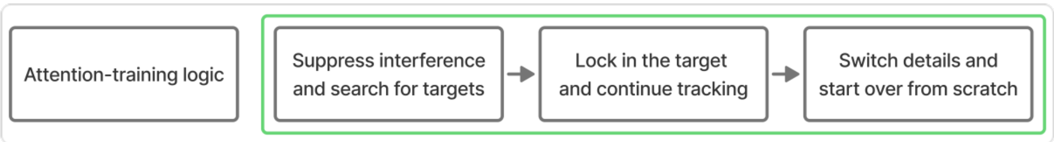

Figure 11. Attention-training logic, drawn by the authors

The paradigm can be operationalised in multiple ways:
1. Lock-on: Use ambient cues (bird-call direction, light-shadow changes) to locate the target rapidly.
2. Sustained tracking: Time-based tasks (e.g., record butterfly-feeding frequency for 5 min) strengthen attention stability.

3. Detail switching: Force alternation between macro (canopy shape) and micro (insect-bore holes) views to inhibit cognitive rigidity.

7.3 Mechanisms of attention training

The operative mechanism parallels Kaplan's ART model [3], which likens directed attention to a muscle: it must relax in a "low-stimulus, high-fascination" natural setting before it can tense again. As illustrated in Figure 8, the paradigm proceeds through four sequential phases:
1. Induction: students enter a low-stimulus, high-fascination natural environment (e.g., open sky, calm lake, dense forest).
2. Attraction: the facilitator uses minimal-language questions ("Where is the long-legged bird?", "Can you spot the white dove?") to draw attention to a salient individual.
3. Deep focus: attention is channelled to finer features, maintaining high concentration for 2 min while students sketch or map the observed traits.
4. Release: attention is gently returned to the wider environment, completing the training cycle.

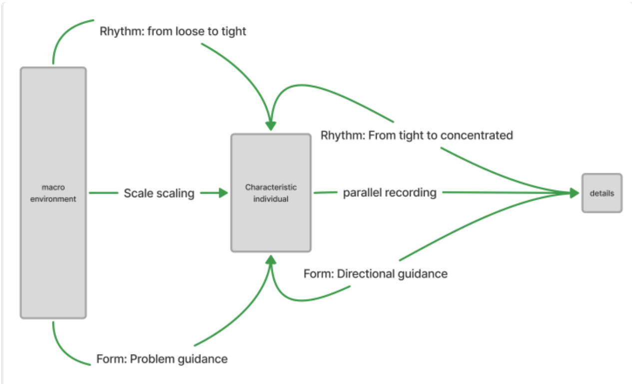

Figure 12. Attention training mechanism, drawn by the authors

7.4 Auxiliary conditions: complex natural background (soil, leaves, water, sky)

Complex backgrounds are not distractors but the core training medium. Ubiquitous in natural settings, these backgrounds compel learners to immerse their senses in "soft-fascination" inputs—landscapes, natural sounds, etc.—where micro-stimuli foster cognitive development and allow attention to disperse and relax [40]. Multi-sensory cues such as a breeze on the skin, the scent of rain-soaked earth, insect timbres, or shifting tree shadows integrate to optimise perceptual precision and enhance attention allocation [29].

7.5 Results evaluation

To structure the evaluation of the final impact of the lesson, the study combined two lenses: a teacher-rating checklist and a close look at what children actually produced. The procedure is split into three clear phases—before, during, and after the lesson. [41] Such design comes from the research on both literature and case studies.

1.Before the lesson：teachers run a 5-minute "free-drawing warm-up" to capture baseline attention. While children draw, teachers quietly note how long each child stay on task, how often he or she switches activities, and any signs of distraction. These naturalistic sketches serve as each child's personal "starting line" for later comparison.[42]

2.During the lesson：teachers use a one-page observation form (see Table 1). Every three minutes they quickly code three aspects of attention—orienting, sustaining, and executive—using three simple symbols:● = worked independently；▲ = needed one prompt；■ = needed several prompts. At the same time, teachers collect every physical product the children generate (puzzle pieces fitted, collage items glued, block towers built, etc.). These artefacts act as concrete "footprints" of attention that could be re-examined later.[43]

3.After the lesson：post-lesson, the artefacts undergo a structured four-point analysis: density of fine detail, regularity of colour use, completeness of closed forms, and total time-on-task. These quantitative

indices are cross-checked against the in-lesson behaviour codes, together forming an integrated profile of each child's attentional capacity.[43]
4.Monthly follow-up：numbers are fed into a simple spreadsheet that automatically generates a radar chart for every child. The three attention axes (orienting, sustaining, executing) are plotted once a month so teachers, parents, and even the children themselves can see at a glance “which attention muscle” was growing and which still needs exercise.[44]

Table 2. Teacher Observation Record Form,drawn by the authors

Dimension	What to watch	Rating scale & criteria
Orienting Attention	Head/eye/body turn toward the instructed stimulus	3 = Good: Turns quickly and accurately. 2 = Fair: Turns after 1 prompt or a delay. 1 = Needs support: Wrong turn or no clear orienting response.
Sustaining Attention	Time-on-task and persistence with a single activity	3 = Good: Completes task independently without reminders. 2 = Fair: Completes after 1 prompt or reminder. 1 = Needs support: Abandons task quickly or switches repeatedly.
Executive Attention	Task-switching, rule-following, impulse control	3 = Good: Switches smoothly and follows rules. 2 = Fair: Switches or follows rules after 1 prompt. 1 = Needs support: Resists switching or needs multiple assists.

8. DISCUSSION

The Natural-Attention Training Model (Relax-Task Alternation Model, RTAM) proposed in this study provides a structured framework for cognitive intervention in nature education. Future work should complete a three-tier validation loop to consolidate the theoretical support:
1.Ecological curriculum development:
Design dynamic task chains (e.g., “biometric spotting → trajectory tracking → rapid switching”) to upgrade fragmented forest-school activities into a standardised curriculum model.
2.Multimodal attention measurement:
• Combine Child-ANT behavioural testing with mobile eye-tracking to quantify visual-exploration efficiency in natural scenes (e.g., target-lock latency, gaze-switch frequency);
• Establish a dose–response model linking pupil-diameter change to cognitive-resource recovery [8].
3.RCT experimental design：
Stratified sampling of typical 3- to 6-year-old children and ADHD cohorts, assigning:
• Experimental group: RTAM lessons (5 min nature exposure + 10 min dynamic task) × 3 cycles;
• Control group: traditional nature experience (free exploration) & classroom ANT training.
The core hypothesis of the study is that, if the intervention is effective, the experimental group should exhibit greater improvements in inhibitory control, though this remains to be proven. If empirically supported, the model would catalyse paradigm shifts in two domains.
1. in Natural Education: moving from experience-led practice to evidence-based, precision curriculum design, offering a non-pharmacological intervention option for children with ADHD.
2. Attention Training: transcending the ecological-validity limits of laboratory tasks and establishing an adaptive, bio-sensor-fed system (e.g., automatic task-difficulty adjustment via pupil data).

9. CONCLUSIONS AND OUTLOOK

Nature education is more than a vehicle for cognitive restoration; it is a core pathway for cultivating ecological literacy and holistic human development. While current studies reveal its substantial potential, the empirical validation of theoretical mechanisms could benefit from further studies, and practical outcomes may be influenced by multiple factors—teacher expectancy, environmental variability, implementation efficiency, and on-site changes—cautioning against hasty generalisation. Future work should deepen basic research while strengthening local adaptation of educational practice, ensuring that nature truly becomes a “measurable educational resource.”

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